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WORLD PETROLEUM

MARCH 1956

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TODAY'S LESSON...

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Blending Hydrocarbons for
Maximum Octane Potentials

By F. D. BUERSTETTA
Ethyl Corporation, Detroit, Mich.

The manufacture of high-octane gasolines to meet today's and tomorrow's automotive demands is putting increasing pressure on the refiner. To meet these requirements, the available hydrocarbon components in the refinery must be blended to best advantage to give maximum performance on the road.

Each octane number at the 100-octane level may cost as much as 15 to 20 cents per barrel. Thus there is a marked incentive for insuring that every laboratory octane number, obtained at this great expense, provides corresponding antiknock performance in cars on the road.

Hydrocarbon blends studied

As part of a continuing Ethyl Research program to establish the fundamentals of laboratory versus road antiknock quality, a study was recently conducted in which the behavior of blends of pure C_7 and C_8 hydrocarbons was examined.

Within this C_7—C_8 range, the four basic hydrocarbon types—olefins, paraffins, naphthenes and aromatics—were blended in varying proportions. Actually, a mixture of iso-octane and n-heptane was used as the paraffin constituent to permit maintenance of a constant Research octane number while investigating the effects of tetraethyllead concentration and variations in hydrocarbon-type composition. Toluene, di-isobutylene and methylcyclohexane were selected to represent the aromatics, olefins and naphthenes, respectively. Each of these hydrocarbons was blended in concentrations of 20, 40, and 60 per cent by volume with the proper paraffin mixture, giving nominal Research octane levels of 92, 96 and 100 at each of four tetraethyllead concentrations—0.0, 0.5, 1.5 and 3.0 ml. per gallon.

Each blend was evaluated in single-cylinder laboratory test engines and was then rated in the 9 to 1 compression-ratio engine of a 1955 passenger car equipped with an automatic transmission. Road ratings were made by both the Modified Uniontown and Modified Borderline techniques.

Road appreciation defined

Some of the test results are summarized in terms of road appreciation, which is the road antiknock rating of a fuel minus its Research octane number—or the bonus obtained in actual engine performance over the indicated laboratory knock rating.

The general analysis of data may permit a refiner to achieve better road performance than could be secured by using only Research octane number as a guide. It will be seen that aromatics should be maximized and olefins minimized as much as possible when making top octane fuels. Since most of today's catalytic reforming processes eliminate naphthenes through dehydrogenation to aromatics, consideration of them is somewhat academic, but nonetheless interesting.

Further evaluation of the large quantity of test data obtained from this project indicates a most interesting correlation between appreciation and the concentration of tetraethyllead. It shows that appreciation at any given sensitivity level increases with lead concentration.

Send for your free copy of a technical paper entitled "Octane Possibilities with C_7—C_8 Hydrocarbons" by F.D. Buerstetta and T. W. Warren. Address your request to Box 16, Ethyl Corporation, 100 Park Avenue, New York, N. Y.

Conclusions

The general conclusions which can be obtained from the study are as follows:

1. Best over-all antiknock performance can be obtained by blending a high proportion of aromatics with paraffins and adding the maximum amount of tetraethyllead.

2. Where low-speed knock resistance is critical, high aromatic content is necessary.

3. Where high-speed antiknock performance is critical, high aromatic content is less important, but maximum tetraethyllead concentration is still essential.

HOW Ethyl Research can help you

At today's high octane levels, the science of blending hydrocarbons has taken on more and more importance. As a service to the oil industry, Ethyl Research has launched a hydrocarbon blending program of its own to complement the intensive effort which the industry is devoting to this problem.

We are now testing many new blends in our laboratories and in high-compression engines on the road. Much of the data from these tests is being interpreted in terms of "road appreciation" to give refiners a better idea of the effectiveness of each blend. Write for a copy of "Octane Possibilities with C_7—C_8 Hydrocarbons"—another in the continuing series of reports from the Ethyl Corporation on fuel blending and other studies of vital interest to refiners today.

For further information, just call your Ethyl Representative. He'll be happy to arrange an appointment for you with one of our Technical Representatives.

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McCullough Log Enables Precision Perforating of 5′ Pay Zone

Discovers 8′ Error in Electric Log and Casing Measurements

Operator of this old well ran an electric log which located a new, possibly productive, 5′ sand.

McCullough was then called to run a Neutron Log. The Neutron curve confirmed the productive possibilities of the new zone, but also discovered that both the electric log and casing measurements were 8′ in error.

The well was plugged back to 6800′ and perforated according to McCullough measurements.

Thirty ½" improved Ogival Bullets were shot in the 5′ sand in one run by a 3½" O.D. McCullough M-3 Gun. Casing was 5½" O.D. 17 lb.

The well started flowing through the casing before the M-3 Gun was out of the hole.

If the McCullough Radiation Well Logger had not discovered the 8′ measurement error, the 30 shots would have missed the pay zone entirely.

It always pays to rely on the accuracy and dependability of McCullough's Radiation Well Logger.

McCullough Log Locates and Defines 11 New Pay Zones

Accuracy of McCullough Radiation Well Logger Permits Sharp Shooting of 11 Thin Zones for 138 B/D Increased Production

This was an old well in an established California oil field. Production had fallen to five barrels of oil per day.

Believing better production was possible, the operator decided to log and re-perforate the well. McCullough's combination Gamma Ray-Neutron Log was run from 4380′ to 5645′, locating several small, promising stringers of untried sands above the original pay zones.

A simultaneous collar log accurately located casing collars in relation to these thin sands, thus assuring "pin-point" accuracy in perforating.

The two original producing sands were re-shot, four holes per foot, with 26 improved ½" Ogival Bullets from McCullough M-3 Guns and with 26 McCullough Standard Casing Glass Jets.

Above these zones were the 11 small sand stringers ranging in thickness from 4 feet to 13 feet. Intermediate zones, lying between the productive sands, which were not to be perforated ranged in thickness from 5 feet to 103 feet.

Accurate measurement means "putting the shots where they count"... and the "pin-point" accuracy of the McCullough Radiation Well Logger makes sharp shooting of thin zones practical... assures uniform perforating coverage of any zone, thick or thin.

The 11 pay sands were perforated with 256 shots, four holes per foot, by 3½" O.D. McCullough M-3 Perforators firing ½" Ogival Bullets. Production increased from 5 to 143 barrels of oil per day.

This is only one of many actual jobs where the accurate, reliable, easily interpreted information provided by the McCullough Radiation Well Logger has located and defined multiple pay zones, tied-in casing collar locations and permitted precision perforating for best possible production.

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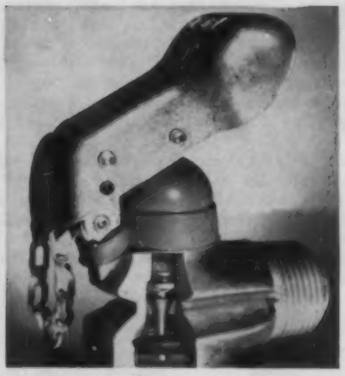

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Washington PIPE LINE

By Joseph B. Huttlinger

With the veto by President Eisenhower, American natural gas producers, some 5,000 in number, face the prospect of strict federal controls for months and maybe years to come.

The severity of the control now is in the hands of the U.S. Federal Power Commission, which has been working out its manner of control for the past 20 months.

Only time will tell, further, whether the FPC controls will extend beyond natural gas and over into the production of crude oil as well. There are signs that this is something for American oil men to watch for.

As things stand, the FPC now has the power to set the price at which a natural gas producer may sell his gas; the amounts of gas he may sell, to whom, and whether he may stop selling gas. This is virtually complete control.

At present, the FPC is seeking a total of $2,397,904 for carrying out controls over independent producers of natural gas and over long distance pipe line companies. This is some 10% over the amount it has for the year which ends next June 30. Chances are, the FPC will consider asking more funds, in light of the legislative picture.

The prospect of continued controls is a bitter blow to members of Congress from oil and gas producing states, and to oil and gas producers. They had expected to be free of the controls, once the Congress voted legislation to remove, or to ease up the controls.

The veto by President Eisenhower was a surprise, when it came on Feb. 17, and not only because the President, through his aides and Cabinet members, practically asked for the gas bill and in the form in which it was passed.

The veto was a surprise, also, because in rejecting the measure, the President said flatly "I am in accord with its basic objectives." The legislation, or something like it, "is needed," he said, because the present types of controls over independent gas producers "will discourage individual initiative and incentive to explore for and develop new sources of supply."

But the President vetoed the message. The reason, he said, is "highly questionable activities" which are "arrogant" and "in defiance" of acceptable standards of propriety."

So the President wants the bill, but he vetoed it when it reached him.

The names of H. B. Keck, president of Superior Oil Co., Elmer Patman, an attorney for the company and others have been in newspaper headlines in connection with a $2,500 campaign contribution to Senator Francis Case, R., S.D. There is no doubt, this is the "questionable" affair the President had in mind.

Senate and House leaders at once dropped all thought of trying to override the veto of the President. The House voted 209 to 203 for the measure; the Senate voted 53 to 38 for it. A two-thirds majority of those voting in each chamber is needed to override. And most members of Congress thought the measure dead for this year. Some thought the measure, or anything like it, dead for all time.

The veto message is bound to have a tremendous impact politically, as the Republican party has received generous support from oil and gas executives during the past few years. Whether this kind of help will be forthcoming in the future, is doubtful.

The comments on the veto barely hinted at the bitterness over the veto on the part of supporters of the measure. Senator Lyndon Johnson, D., Texas, said, "the veto is difficult to understand; he is vetoing a bill which he himself believes serves the interests of all of our people."

Senator J. W. Fulbright, D., Ark., the sponsor of the measure, accused the President of "courting the favor of the electorate in a few large metropolitan centers." Rep. Oren Harris, D., Ark., the House sponsor, went so far as to call the action "one of the worst pieces of demagoguery," and "a direct attack on Congress, which puts a stain on one of the greatest industries in our country because the representative of one company made a stupid mistake."

Senator Wayne Morse, D., Ore., who had vigorously opposed the measure, called the veto the action of "a split intellect." He said, "The President is trying to walk down both sides of the street. He won't get away with it."

Looking toward the future, Frank M. Porter, president of the American Petroleum Institute, said that any new bill must be started on its way by the President himself. "The President's veto," said Porter, "killed the legislation which he has endorsed in principle.

"In light of the political and legislative uncertainty which that veto has created, as well as the chaos which will result in the natural gas producing industry, the initiative for any new legislation, which certainly will be needed, must now come from the President if it is to be successful."

May Link Gasoline Tax to Roads

The U. S. Congress is studying proposals to link the revenue from the federal excise tax on gasoline to the construction of highways.

This is something new; if it goes into effect, it is likely to create a Pandora's box of troubles for tax collectors and, probably, for the oil industry for years to come. The linking threatens to make the federal gasoline tax permanent, at least as long as the U. S. is helping to finance highway building.

When originally passed in 1932, the federal gasoline tax, then one cent a gallon, was "temporary," and for "general revenue."

Farmers Exempted—If the gasoline tax is earmarked for highways then this at once prompts gasoline users who don't ride the highways to seek examption. Already, farm use of gasoline is being exempted by action of the U. S. Congress. Once, this was called "administratively impossible," but this election year politicians saw it differently, and are providing for the farmer to pay the tax, and then apply for a refund. Airlines, ships and industry using gasoline may be expected to ask exemption.

Congress sees the sense in such requests. The Democratic bill to finance a highway program would raise the tax to three cents a gallon; but the increase would apply to "on highway" use. Along with aircraft and ships, city bus systems would pay only two cents a gallon.

Biggest Spending Program—The drive for exemptions, further, would extend to "off-highway" users of diesel oil, tires and tubes, autos and trucks, camelback and the like.

The Democratic plan for stepped up highway construction, in its latest version, calls for tax increases to bring in $35 billion over the next 15 years for highway construction. This is about $12 billion more than would come in under existing federal taxes on gasoline, tires, autos and the like.

It is the largest, single peacetime spending program ever authorized in the history of the civilized world.

Tax Increases Proposed—The tax increases proposed:

(1) Add a penny, for a total of three cents a gallon, to the federal excise tax on gasoline; (2) Add a penny, for a total of three cents, to the taxes on Diesel and special motor fuels; (3) add three cents, for a total of eight cents, to the per pound tax on tires; (4) Add two percent, for a total of 10 percent to the tax on trucks, trailers and buses; (5) Add a new tax of three cents a pound on camelback or retread rubber; (6) Exempt airplanes, boats, city and local transportation from the increase in gasoline and Diesel fuel taxes.

These taxes, of course, are federal. The states have their own taxes. In the case of gasoline, the state and federal taxes will run the total tax on a gallon to as much as 10 cents in several states.

Depletion attacked

The income tax depletion allowance for crude oil and natural gas production is under attack once again in this Presidential election year. Odds are against change but there will be much talk.

The attack is the outgrowth, in part, of the successful fight of oil and gas producers for passage of a natural gas bill. This was accomplished in February of this year. Two days after the passage of the measure, Senator John Williams, R., Del., and three other Senators introduced legislation calling for a slash in the depletion allowance from 27.5% to 15%. The other Senators are Margaret Chase Smith, R., Maine; William A. Purtell, R., Conn.; and George Aiken, R., Vt.

A spirited attack on the depletion allowance came during the gas bill debate from liberals such as Senators Hubert Humphrey, D., Minn.; Paul Douglas, D., Ill.; and Herbert Lehman, D., N. Y. The new bill adds a bi-partisan flavor to the move on the depletion.

The safety of the present depletion lies, however, in the endorsement of the depletion given by Secretary of the Treasury George Humphrey. Without administration support, it is difficult to change a tax provision of a major nature. "I don't think depletion is a loophole," Secretary Humphrey told reporters recently. "I think it very definitely is not a loophole. Proper depletion is a very proper deduction and a very desirable one from the whole point of our economy."

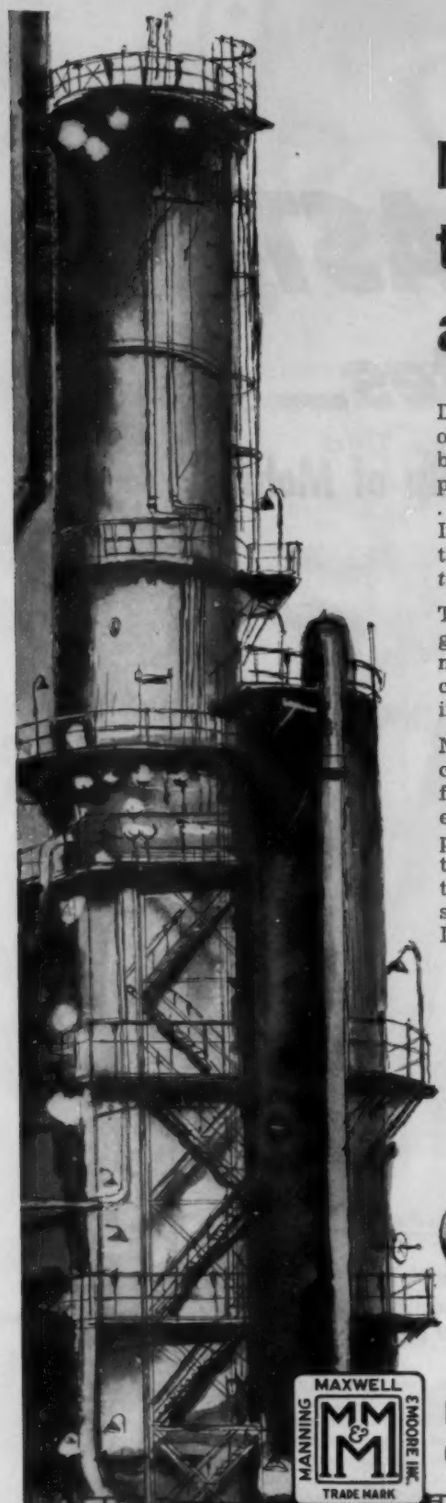
Oil Executive in Foreign Aid Post

Walter Schaefer, former executive of Standard Oil Co. (N.J.) has been named a special assistant to the International Cooperation Administration. Mr. Schaefer was with Standard Oil for 40 years, and retired in 1950 when he was assistant comptroller.

He will be special assistant to John B. Hollister, director of the ICA, which operates the program of billions in aid to foreign countries each year. The post is a new one, and covers policy on budgetary and foreign aid fund uses.

Petroleum Official Appointed Economic Counselor

Robert H. S. Eakens, a top petroleum official at the U.S. State department for several years, is shifting to Santiago, Chile, in April where he will be economic counselor to the U. S. Embassy. Earl Beckner, assistant to Mr. Eakens, is in line to advance to the vacancy which will be left in Washington.



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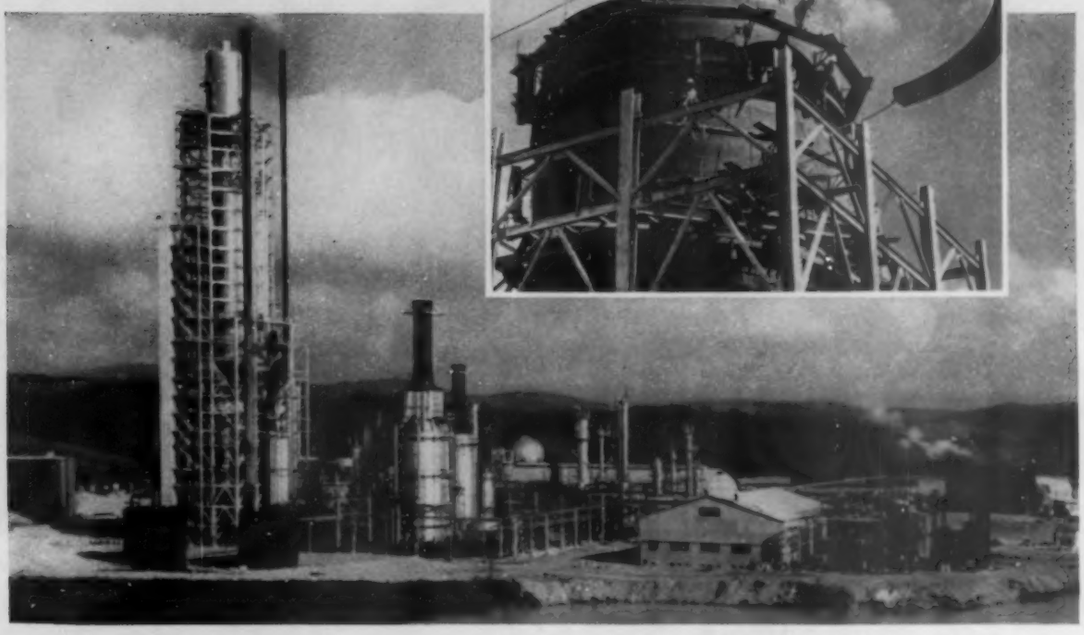

Top: An air duct section for the TCC kiln being raised into place.
Bottom: General view of Capuava Refinery.

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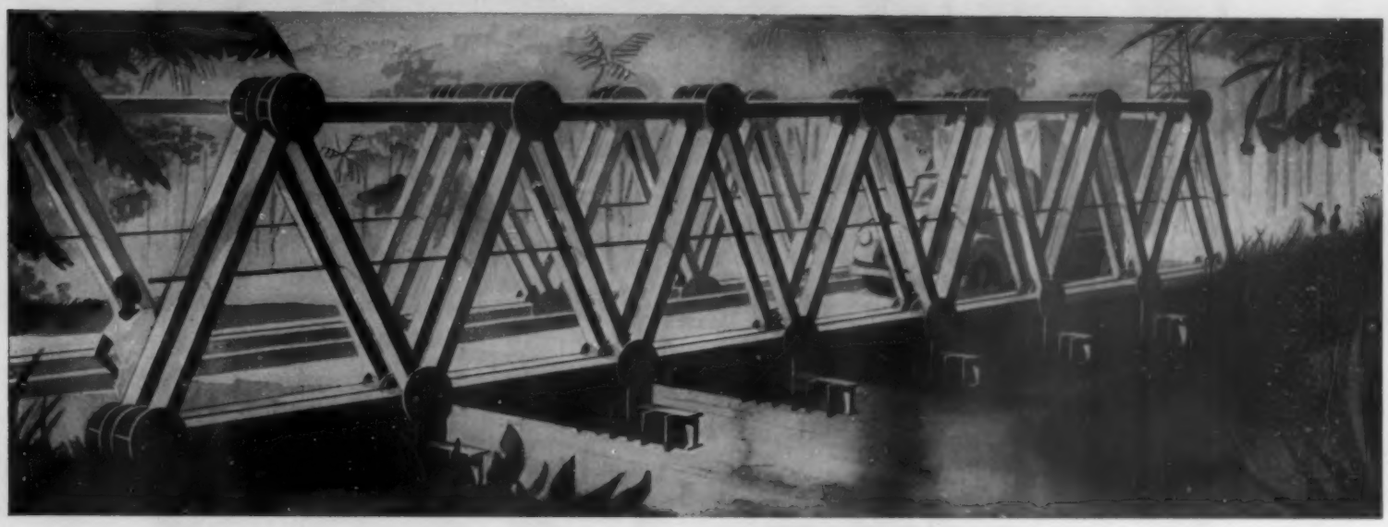

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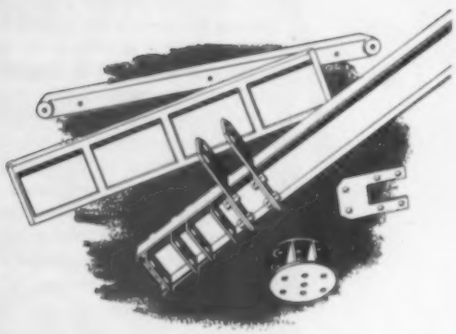

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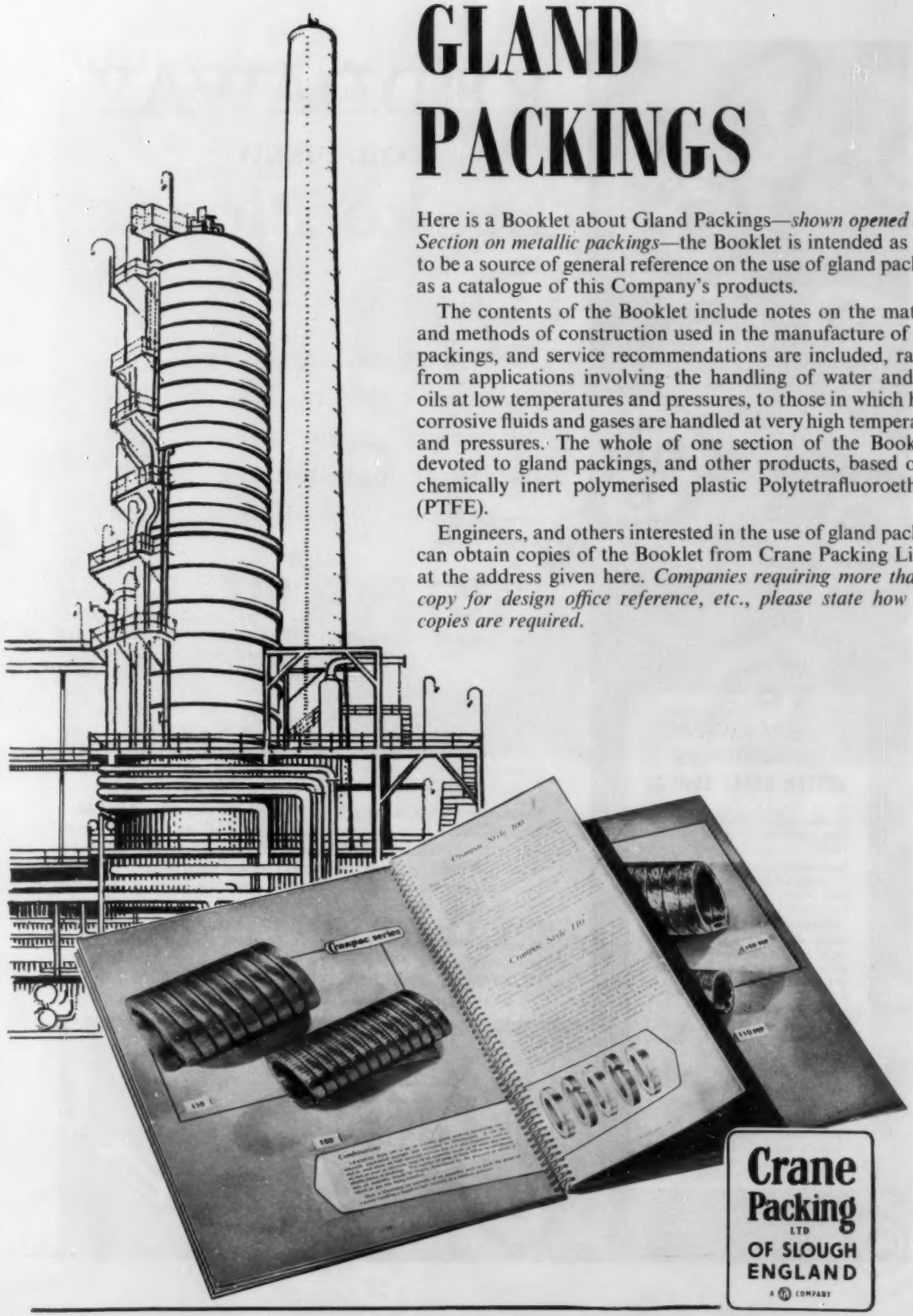
GLAND PACKINGS

Here is a Booklet about Gland Packings—*shown opened at the Section on metallic packings*—the Booklet is intended as much to be a source of general reference on the use of gland packings, as a catalogue of this Company's products.

The contents of the Booklet include notes on the materials and methods of construction used in the manufacture of gland packings, and service recommendations are included, ranging from applications involving the handling of water and light oils at low temperatures and pressures, to those in which highly corrosive fluids and gases are handled at very high temperatures and pressures. The whole of one section of the Booklet is devoted to gland packings, and other products, based on the chemically inert polymerised plastic Polytetrafluoroethylene (PTFE).

Engineers, and others interested in the use of gland packings, can obtain copies of the Booklet from Crane Packing Limited at the address given here. *Companies requiring more than one copy for design office reference, etc., please state how many copies are required.*



This is the rig for 8,000 ft. drilling!

... say Drilling Contractors EVERYWHERE

This "Oilwell" No. 66 Rig is doing a great job for another West Texas Contractor

FROM Canada to South America . . . from California to Pennsylvania . . . Drilling Contractors, one by one, are discovering that it pays to back up their bids on 8,000 ft. work with an "Oilwell" No. 66 Rig and companion profit-making equipment.

In fields where proven production is under development, crews have drilled an extra well with No. 66 Rigs, in time saved drilling four or five wells where average equipment is in use.

MOVING time is saved . . . because this lightweight, fully-unitized draw works with two or three engines and drive, is mounted on a single skid base. This greatly reduces tearing down, moving and rigging-up operations.

OPERATING time is saved . . . because fast-acting air controls make the horsepower respond immediately to the driller's needs, whether the rig be furnished with straight mechanical or torque converter drive.

MAINTENANCE time is saved . . . because major rotating parts are oil lubricated by a forced-feed circulating system and a minimum number of grease fittings are employed. Guards are fabricated to provide quick access to the inside of the draw works for inspections and adjustments.

***BEFORE YOU BUY** . . . another rig in this class, let us show you the nearest No. 66 "on location." You'll see for yourself why an ever-growing list of Drilling Contractors are saying: "This is the rig for 8,000 ft. drilling."*

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The quality Check Valve for *your* service, in materials, sizes and the pressure range for your special requirements.

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Dominion Tilting Disc Check Valves are being supplied for the 45,000 BBL per day Imperial Oil Refinery at Dartmouth, Nova Scotia.

May we send you our Bulletin No. 211-P

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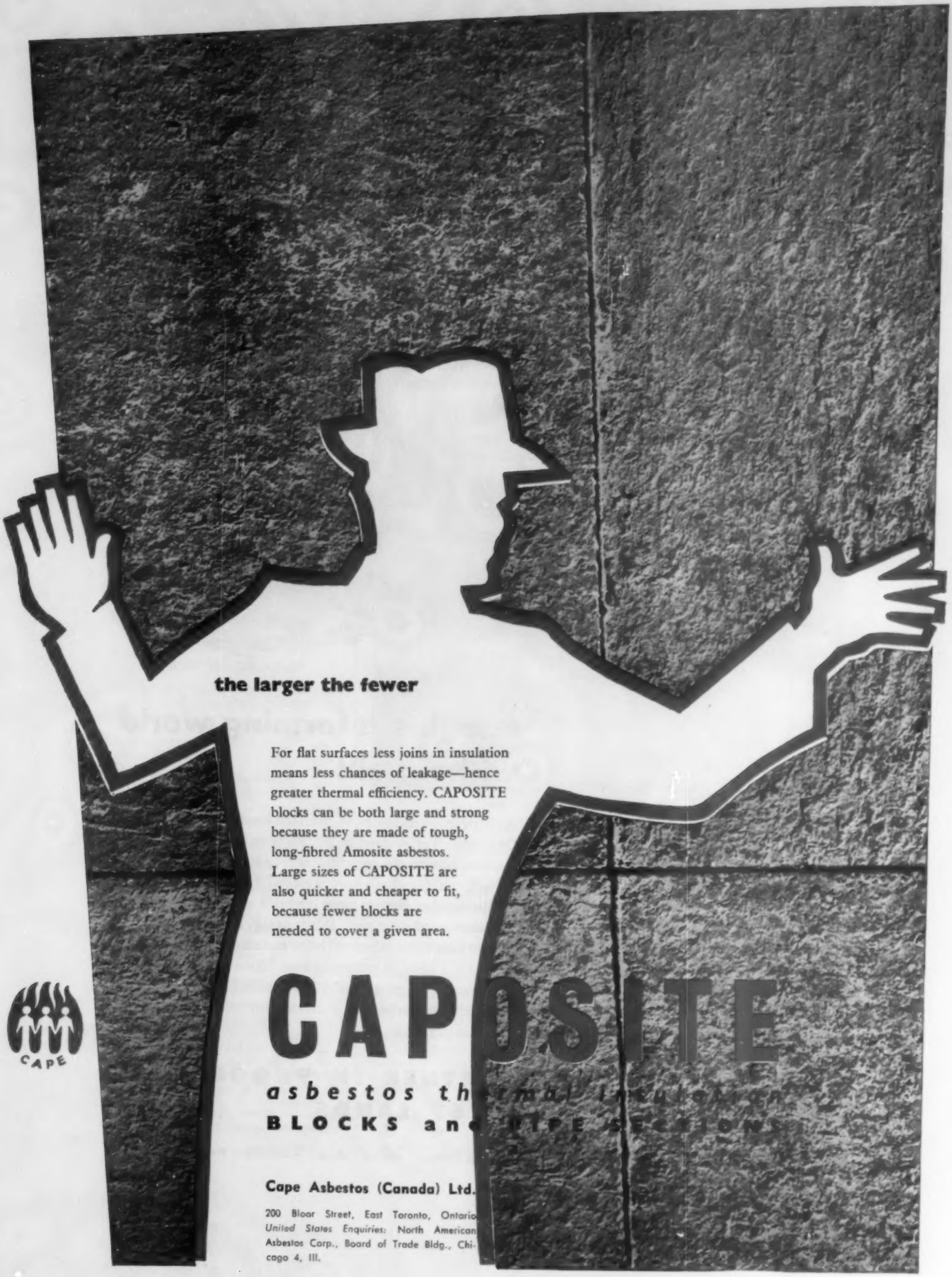

the larger the fewer

For flat surfaces less joins in insulation means less chances of leakage—hence greater thermal efficiency. CAPOSITE blocks can be both large and strong because they are made of tough, long-fibred Amosite asbestos. Large sizes of CAPOSITE are also quicker and cheaper to fit, because fewer blocks are needed to cover a given area.

CAPE

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BLOCKS an[illegible] PIPE SECTIONS

Cape Asbestos (Canada) Ltd.

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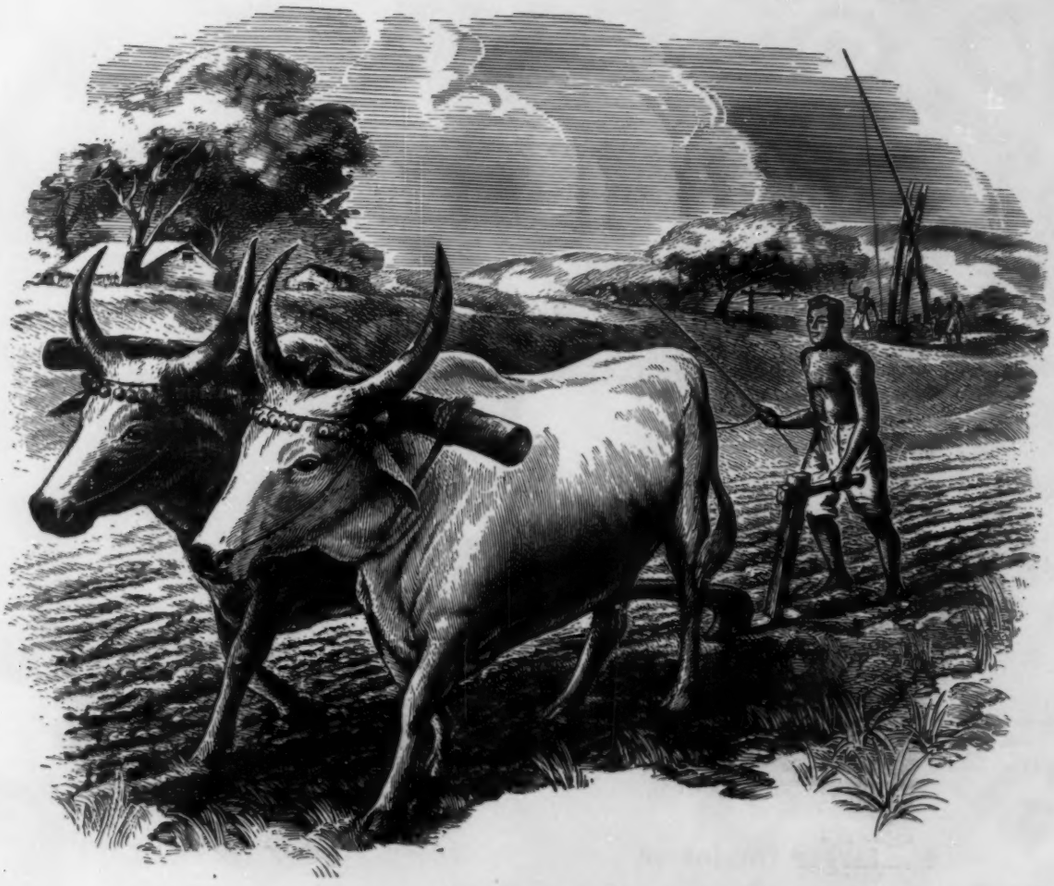

Imagine a farming world without oil!

As population increases, so must the food supply. Obviously. Yet, without proper implements — tractors, combines — agricultural progress as we know it could not have been achieved. For it is such equipment that permits more intensive, more productive and more profitable farming. And it is oil that runs this equipment, helps maintain and protect it. Caltex, in supplying finer fuels and lubricants to the peoples of 67 free nations, is indeed gratified to be part of this immeasurably important cycle.

CALTEX

PETROLEUM PRODUCTS

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PETROLEUM CHEMICALS DIVISION

NEWS

March ★ One of a Series of Interest to the Petroleum Industry ★ 1956

Question Box

1. ARE YOU having trouble keeping costs down as octane ratings go up?
   The new Du Pont service described at right can help you with this problem.
2. DO FOULED heat exchangers plague you with costly downtime and spoiled product?
   Du Pont FOA-2 may help solve this problem.
3. IS THERE A DANGER of additive extraction when fuel oils pass through dehydrators?
   The next page has an article on this subject.
4. WHO can help you get the highest octane at the lowest refining cost?
   See next page.

FOA-2 reduces heat exchanger fouling—helps keep process unit on stream longer

Fouled heat exchangers cost time and money and premature process unit shutdowns.

Du Pont Fuel Oil Additive No. 2 (FOA-2) promises relief from this frequent and troublesome problem.

A little does a lot

Fouling due to unstable stocks such as coker distillates can be minimized by adding FOA-2 in concentrations of as little as 20 to 30 lbs. per 1,000 barrels. It should be added at the beginning of the processing run.

In cases where the heat exchanger fouling is severe enough to cause shutdowns as often as every few days, this treatment will generally extend, to as much as a month or two, the period between shutdowns. And during this extended operating time, FOA-2, as a result, will help to reduce the loss in heat transfer coefficient.

Useful in pipelines, too

Another effective application for FOA-2 is for cleaning pipelines. In concentrations of 50 lbs./1,000 barrels, in No. 2 distillate, it does an excellent job of keeping the contamination in suspension and removing it in advance of the new product.

Why not try it? Its rapid, thorough cleaning will mean lines that are free of contamination and ready for clean product service immediately.

Other uses

Du Pont Fuel Oil Additive No. 2 was originally developed as a stabilizer and dispersant for home heating oils. As such, it does a highly efficient job of preventing and dispersing sludge formations that cause screen and filter clogging.

In addition – being a nonmetallic *ashless* additive – it does not leave a metallic ash deposit which can foul the operation of the electrical system. Thus, it helps to prevent ignition failures that cause customer dissatisfaction and wasteful service calls.

In diesel fuels, the excellent dispersant action of FOA-2 improves filterability. In this way, it helps to eliminate most injector-sticking and filter-plugging problems.

THIS DU PONT TECHNICAL SERVICE MEANS...

More octane numbers per dollar

Octane requirements are increasing so fast that many refiners are facing the choice of either a squeeze on their profits or an advance in their gasoline price. This predicament is brought about by the pyramiding costs of each octane number increase in the 90 to 100 range. In this connection, there are times when a refinery technologist experienced in this specialized field may be of considerable help in the control of costs.

Jack S. Bellah, a Du Pont refinery technologist, is shown here discussing a more economical method of obtaining octane numbers.

The Du Pont Petroleum Chemicals Division is glad to offer you the services of such specialists. The value of their services has been proven in a number of refineries during the past year.

Based on market requirements

Unfortunately, most refiners are forced to do a certain amount of uneconomical processing in order to balance their particular market requirements. But this does not mean that substantial savings in processing cannot be realized – by carefully analyzing and adjusting *all* the factors influencing octane costs.

These factors include the particular gasoline blend, the octane level under consideration, and OVER

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DU PONT

PETROLEUM CHEMICALS DIVISION
NEWS

DU PONT

CONTINUED *Octane Economy*

the method of achieving this desired level. These factors, and their relation to each other, will vary with each individual refining operation. Also affecting the octane cost are the spread in value between intermediate fuels immediately adjacent to the gasoline fraction, and the flexibility of the market between these fuels and gasolines.

Tailored to your operations

For these reasons, the Du Pont *octane economy service* also takes into consideration all the market factors which influence your refining operations. Then a thorough study of the actual processing operations is made to determine the most economical course for reaching your desired octane requirements.

How it's done

Assuming that catalytic reforming is today the principal processing variable in gasoline quality control, then the method of operating the reformer determines to a large extent the cost of achieving a desired octane level.

For maximum economy

At all octane levels, the most economical cost results when the optimum combination of catalytic reforming operations and tetraethyl lead dosages is used. In some instances the maximum usage of TEL, 3.0 cc per gallon might be more economical than increasing the severity of the reforming operation. But this is by no means always true. Generally a combination of moderately severe reforming conditions, commensurate with the octane requirements of the existing market situation, and intermediate TEL dosages result in the lowest possible costs.

Valuable aid

By determining the most economical processing steps and reforming severity, in relation to your own individual stocks and market requirements, the Du Pont *octane economy service* can provide a most valuable aid to your own process engineering.

If you would like more information about this service and how it can help you maintain your profit margins, just drop us a line.

HEADS DU PONT OCTANE ECONOMY SERVICE

Jack S. Bellah joined the Petroleum Chemicals Division as Refinery Technologist in 1953. A graduate of the University of Tennessee with a B.S. degree in chemical engineering, he completed a year of study under a T.V.A. chemical engineering scholarship.

For six years, he was employed by the Socony-Vacuum Oil Company. His activities ranged from routine control testing through heavy oils blending, conservation engineering, operations control and equipment testing, unit yields and economic studies, process engineering and product development.

He then joined Mathieson Alkali where he was engaged in chemical engineering development work.

In 1946, he became a process-project engineer at Stanolind Oil and Gas Company in Tulsa. After working on two of the large joint venture gasoline plant projects in West Texas, he joined the Refinery Engineering Company in Tulsa in 1950. There he coordinated all the company's process activities and economic studies.

Do dehydrators remove Du Pont FOA-2 from distillate fuels?

Laboratory and field tests prove the absorption rate is *less than 1%*. And the negligible amount absorbed does not interfere with the water removal efficiency of the bauxite dehydrators.

For example

In a field test, 74,000 barrels of a No. 2 distillate fuel oil were treated with 18.8 pounds of Du Pont Fuel Oil Additive No. 2 per 1,000 barrels. This stabilizer and dispersant was injected into the circulating line of the storage tank while the fuel was being recirculated. The storage tank contained 8 inches of water. Since the fuel was destined for shipment through a pipeline, a dry fuel was desired.

The treated fuel was pumped from the storage tank through two 100-barrel capacity bauxite dryers operating in parallel, then into the pipeline. Each dryer contained sixteen tons of bauxite.

The test fuel was sampled before and after the dryers . . . and at regular intervals throughout the 31-hour shipment.

Results

The fuel was bright and dry when it left the dehydrators. The FOA-2 content of fuel entering and leaving the dryers was equal. It remained uniform throughout shipment.

When the fuel was checked in at destination, no loss in stability was noted and in this respect the fuel proved to be superior to the base fuel without additive.

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A-989

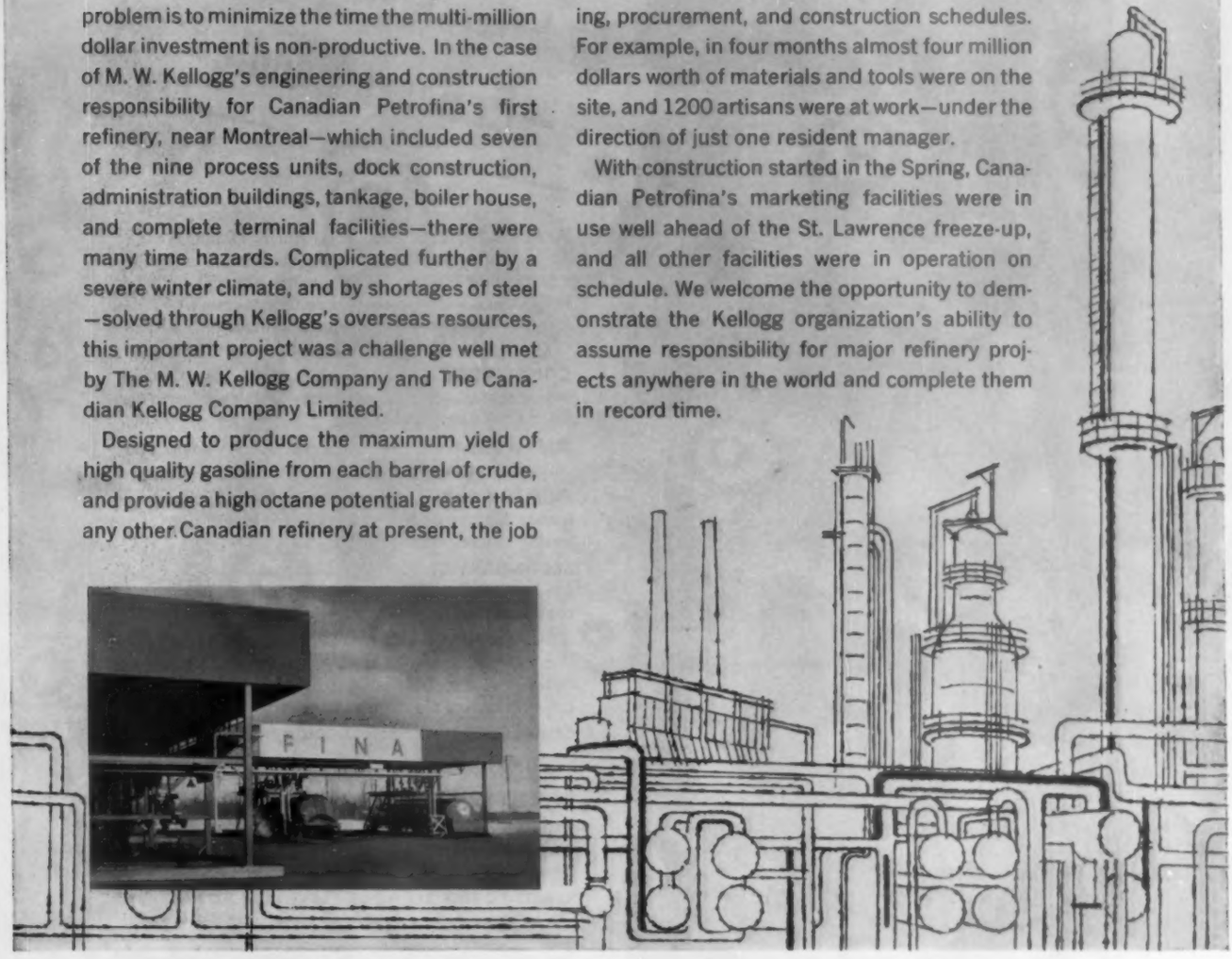
Printed in U. S. A.

Helping Another Oil Refiner Grow —with Fewest Growing Pains

In building a major petroleum refinery, the main problem is to minimize the time the multi-million dollar investment is non-productive. In the case of M. W. Kellogg's engineering and construction responsibility for Canadian Petrofina's first refinery, near Montreal—which included seven of the nine process units, dock construction, administration buildings, tankage, boiler house, and complete terminal facilities—there were many time hazards. Complicated further by a severe winter climate, and by shortages of steel —solved through Kellogg's overseas resources, this important project was a challenge well met by The M. W. Kellogg Company and The Canadian Kellogg Company Limited.

Designed to produce the maximum yield of high quality gasoline from each barrel of crude, and provide a high octane potential greater than any other Canadian refinery at present, the job called for maximum coordination of engineering, procurement, and construction schedules. For example, in four months almost four million dollars worth of materials and tools were on the site, and 1200 artisans were at work—under the direction of just one resident manager.

With construction started in the Spring, Canadian Petrofina's marketing facilities were in use well ahead of the St. Lawrence freeze-up, and all other facilities were in operation on schedule. We welcome the opportunity to demonstrate the Kellogg organization's ability to assume responsibility for major refinery projects anywhere in the world and complete them in record time.



REFINERY PROCESS DIVISION

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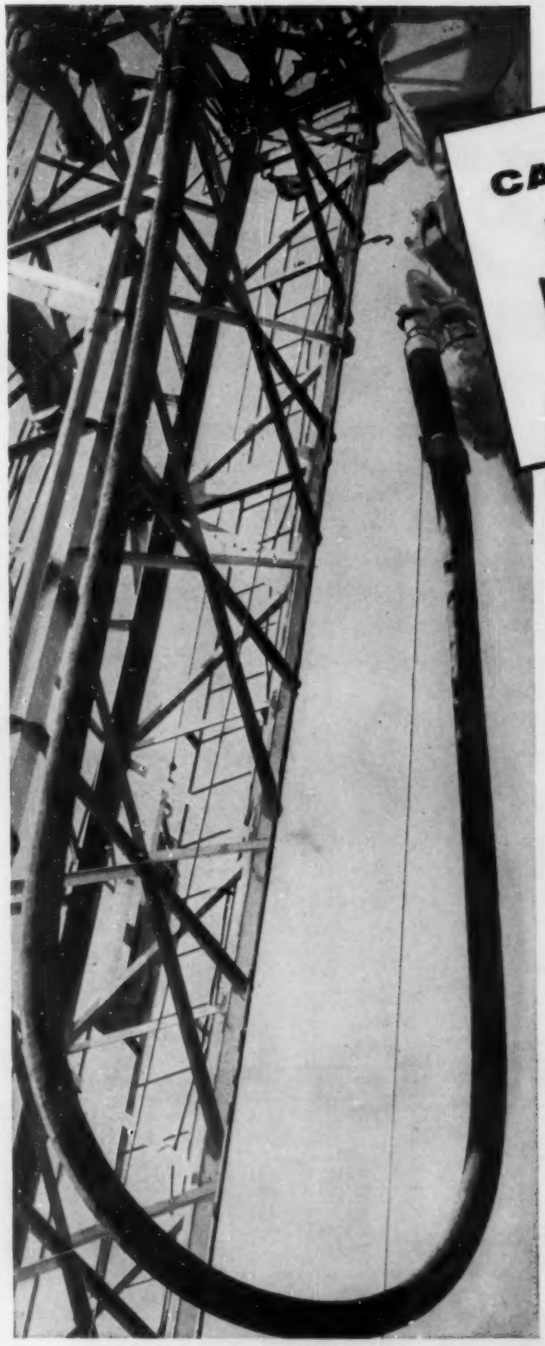


CABLE-REINFORCED ROTARY HOSE IS Lighter—More Flexible —Easier to Handle

APPLICATION: Hewitt-Robins Rotary Drilling Hose cuts operating costs by combining the strength of steel with the long life of rubber flexibility. Although lighter, it is tough and strong to take the continuous impact of highly abrasive drilling muds under extreme pressure and flexible enough to meet the stress of constant bending.

CONSTRUCTION: Hewitt-Robins hose is manufactured to take care of every drilling service—from moderate to the highest pressures encountered.

TUBE is a neoprene-base compound well able to meet all current operating conditions.

PRIMARY CARCASS has multiple plies of premium quality, high tensile fabric, frictioned with the finest quality rubber.

SECONDARY CARCASS is reinforced with high tensile, airplane cable wire embedded in thick cushions of rubber.

COVER is a neoprene-base synthetic compound that staunchly resists oil, sun-checking, cutting, abrasion and extremes of temperature (it also has a longitudinal yellow stripe for ease of alignment).

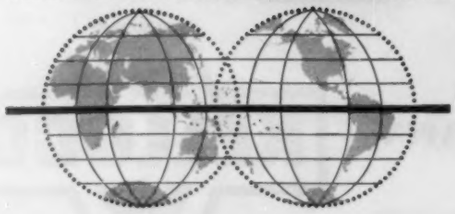
COUPLINGS are the famous Hewitt-Robins Stratoline type.

OTHER HEWITT-ROBINS DRILLING RIG HOSES

HEWITT-ROBINS ROTARY DRILLING FLEXIBLE VIBRATOR HOSE: For hook-up between slush pump and stand pipe—cable-wire reinforced to withstand vibration.

HEWITT-ROBINS BLOWOUT PREVENTER HOSE: For use with all pressure operated blowout preventer units—wire braid reinforced.

HEWITT-ROBINS SLIM HOLE ROTARY HOSE: For portable shallow well drilling rigs and core drill service—wire braided and rayon fabric reinforced.



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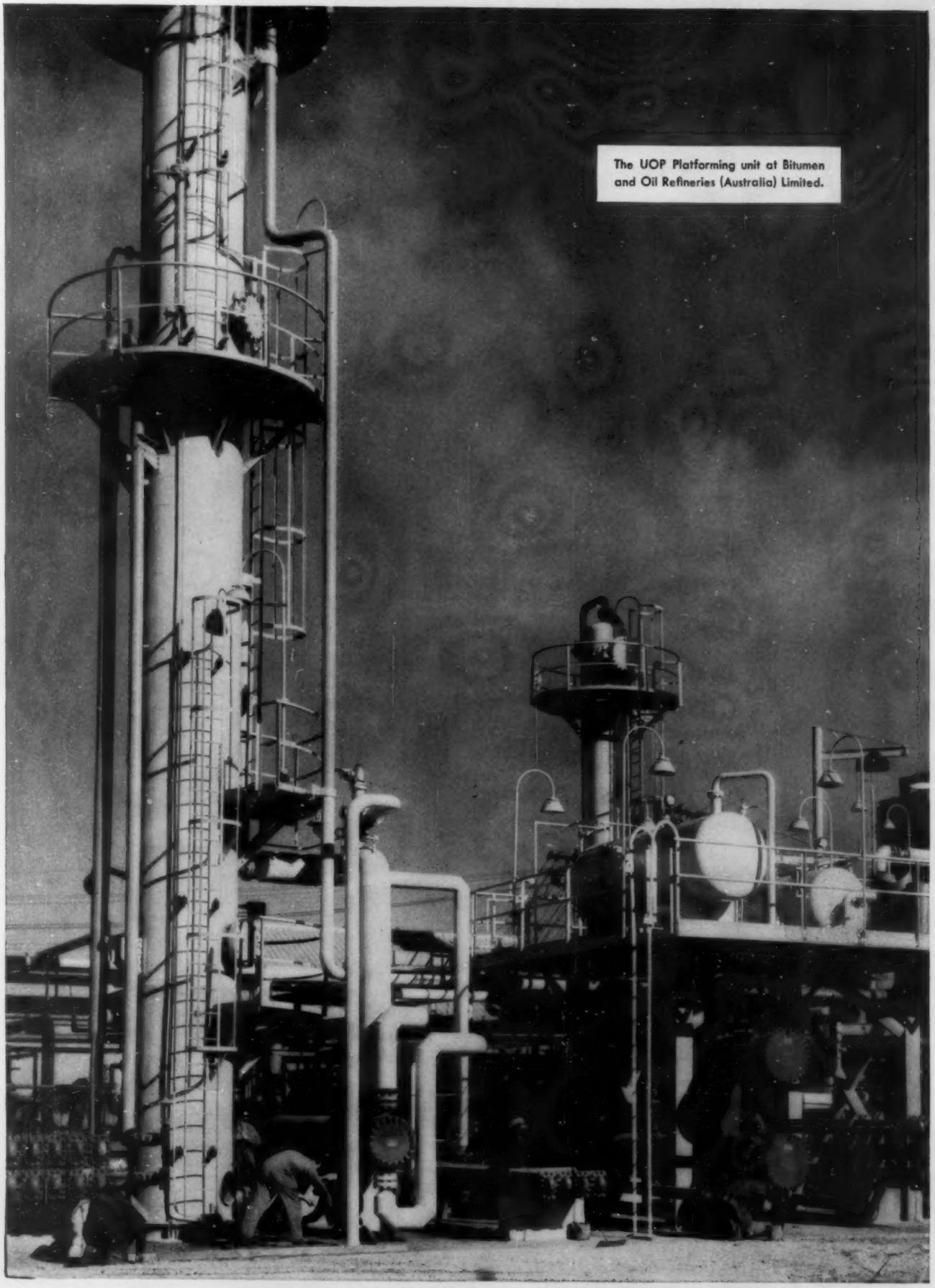
East meets West in Taiwan

Recently in Taiwan (Formosa), Blaw-Knox placed on stream the first Catformer in the Orient for its owners, the Chinese Petroleum Corporation. This plant was designed and procured by Blaw-Knox's Chemical Plants Division, who also supervised erection which was completed in the record time of four months. Chinese labor under the direction of Chinese engineers and skilled technicians performed the actual construction work.

This is just another example of the world-wide achievements of Blaw-Knox engineers, who are ready to help you in the engineering, procurement and construction of a single unit or a complete refinery.

BLAW-KNOX COMPANY
Chemical Plants Division
Pittsburgh 30, Pa. • Chicago 1, Ill.
Birmingham, New York, Philadelphia, San Francisco, Washington, D.C.

油, yu²—oil



The UOP Platforming unit at Bitumen and Oil Refineries (Australia) Limited.

Australian Refiner Reports on 3 Years Operation of UOP Platforming Unit

By E. R. Griffin
General Manager
Bitumen and Oil Refineries (Australia) Limited
Matraville, New South Wales

BORAL has the distinction of being the first refiner outside the American continent to install a UOP Platforming unit, and in more than three years it has operated absolutely trouble-free. Since it went on stream in July, 1952, it has been shut down only for inspections and for cleaning or changing catalyst. In our opinion, this remarkable record was not only achieved because of careful operating control, but reflects, as well, the sound processing techniques of operation provided through the application of UOP fundamental basic research and a well designed and engineered process.

E. R. Griffin

The unit at our refinery set a world record for catalyst life, the first charge having lasted for nearly two years. It was dumped on July 1, 1954, having processed 253 barrels of charge per pound of catalyst. A Platformate yield of 94.1 per cent, based on reactor charge, was realized over the entire run and at the time of dumping, it was still making the 72 octane (motor method) standard grade of motor fuel called for in the local market with the addition of only 1.2 cc. TEL. Making such an octane proved to be an easy job for the Platformer even though Middle East naphthas, processed in the unit, generally are among the least desirable charge stocks for catalytic reforming operations.

Now, the standard grade motor fuel has been increased to 79-81 (research), and a premium grade of 90 research octane has been introduced, both of which are being produced by the Platforming unit without difficulty.

The decision to install the Platforming unit, which had an original design capacity of 1,500 barrels per stream day, came after an exhaustive investigation in which it was determined that this process would give us the flexibility we needed in the selection of a charge stock. Our refinery in Sydney then consisted of a 5,000 B/SD two-stage distillation unit and an asphalt converter unit. A synthetic crude oil, to which was added a small quantity of cracked gasoline, was obtained from the Persian Gulf area for processing into Diesel oil, fuel oil and various grades of asphalt. The gasoline was distilled and sweetened for sale in the local market.

Economics dictated that the processing of whole crude would be more profitable than running synthetic crude because low octane straight run gasoline obtained from whole crude could be upgraded in octane by catalytic reforming with much higher yields than could be obtained by conventional thermal reforming, which was expensive and unsuitable for our requirements.

Having decided to install Platforming, we asked UOP to send an engineer to Australia to assist us in planning for the construction of the unit. Engineering, detailed drafting and purchasing of items not readily obtainable in our country for erection of the Platformer were handled by UOP, which licensed the process. Refinery personnel built the unit.

We decided in 1954 to expand our refining facilities and improve the quality of our other petroleum products. After discussions with UOP on the best course to follow, we concluded that the Unifining process would be most adaptable to our needs. Universal was requested to prepare the engineering and detailed drafting and to purchase hard-to-get items as well as to prepare the design and engineering for revamping the Platformer to increase its capacity to 2,500 B/SD, and to prepare the process designs for a 10,000 B/SD topping plant.

Exhaustive work in Universal's laboratories resulted in the design of a "tailor-made" Unifining unit which processes a combination of Diesel fuel and aromatic light oil produced from an oil gas plant located in Sydney. The Unifining unit has made BORAL one of the first refiners in the world to offer Diesel fuel purified by the use of hydrogen.

In conclusion, we would like to say that our association with UOP not only has enabled us to keep abreast of the most modern refining techniques, but it has made available to us technical "know-how" which has proved invaluable.

DOWN UNDER
BORAL USES UOP
PLATFORMING TO PROVIDE
AUSTRALIAN MOTORISTS
WITH HIGH QUALITY
MOTOR FUEL

designed, engineered and licensed by

UNIVERSAL
OIL PRODUCTS
COMPANY

30 ALGONQUIN ROAD,
DES PLAINES, ILL., U.S.A.

Forty Years Of Leadership
In Petroleum Refining Technology

DEEP WELLS SHOW THE DIFFERENCE!

Tremendous pressures and vibrations in deep wells demand drill pipe and casing that can take severe punishment. That's why well operators use drill pipe and casing made by the Seamless process. Seamless tubing has to be strong because the piercing operation used to forge it shows up defective metal.

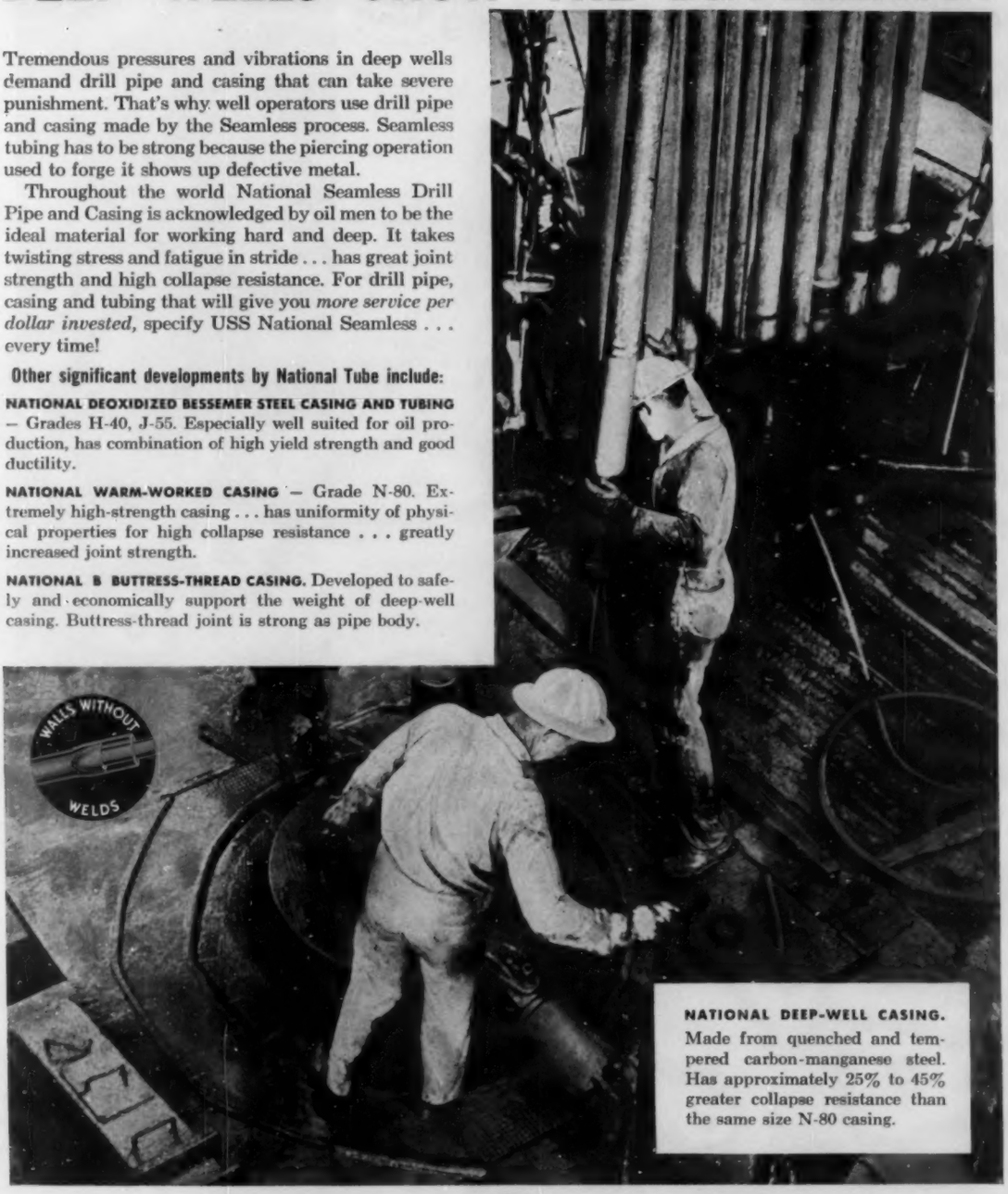
Throughout the world National Seamless Drill Pipe and Casing is acknowledged by oil men to be the ideal material for working hard and deep. It takes twisting stress and fatigue in stride . . . has great joint strength and high collapse resistance. For drill pipe, casing and tubing that will give you *more service per dollar invested,* specify USS National Seamless . . . every time!

Other significant developments by National Tube include:

NATIONAL DEOXIDIZED BESSEMER STEEL CASING AND TUBING — Grades H-40, J-55. Especially well suited for oil production, has combination of high yield strength and good ductility.

NATIONAL WARM-WORKED CASING — Grade N-80. Extremely high-strength casing . . . has uniformity of physical properties for high collapse resistance . . . greatly increased joint strength.

NATIONAL B BUTTRESS-THREAD CASING. Developed to safely and economically support the weight of deep-well casing. Buttress-thread joint is strong as pipe body.



NATIONAL DEEP-WELL CASING. Made from quenched and tempered carbon-manganese steel. Has approximately 25% to 45% greater collapse resistance than the same size N-80 casing.

Look for this trademark . . . USS *. . . your guide to quality steel*

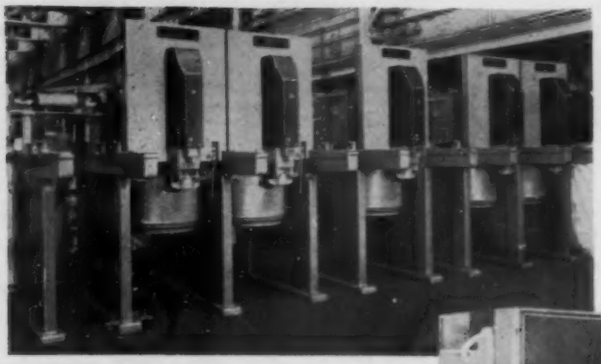
UNITED STATES STEEL EXPORT COMPANY
30 CHURCH STREET, NEW YORK 8, U. S. A.

METALCLAD SWITCHGEAR

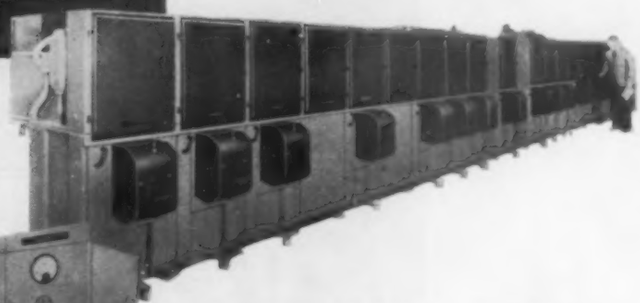
and remote control panels

for Oil Refineries

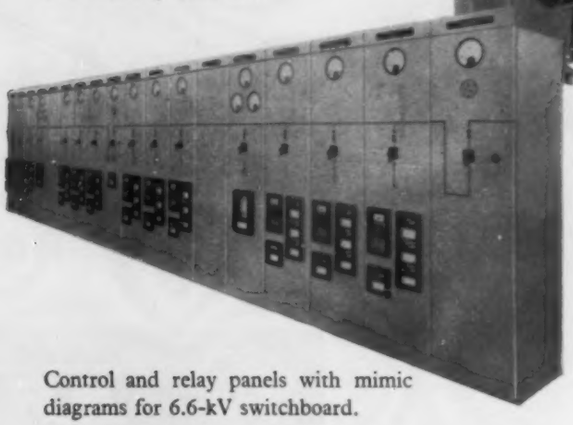
The Burmah-Shell Refineries Ltd. specified BTH 22-kV and 6.6-kV metalclad switchgear for their new Bombay Refinery.



Five-panel, 22-kV, 500-MVA solenoid-operated switchboard for the control of the incoming feeders (from the Tata Power Co., Ltd.) and 7,500-kVA transformers which supply electric power to the whole refinery.



Twenty-panel, 6.6-kV, 250-MVA solenoid-operated switchboard controlling the 7,500-kVA transformers and main refinery feeders.



Control and relay panels with mimic diagrams for 6.6-kV switchboard.

Manufacture is now proceeding with a further two 22-kV, and nine 6.6-kV, units for a third 7,500-kVA transformer and additional refinery feeders; BTH have also supplied a total of eighty-three 6.6-kV, 150-MVA hand-operated metalclad switchgear equipments for the refinery substations.

BRITISH THOMSON-HOUSTON

THE BRITISH THOMSON-HOUSTON COMPANY LIMITED · RUGBY · ENGLAND

Member of the AEI group of companies

A4892

compressor designs also become

New automobile designs with startling advances in styling and performance present their appearance every year. Engines considered to be the last word a few short years ago, have been scrapped in favor of new models possessing greater performance and stamina.

Isn't there also a continuing need for improved compressor designs and performance . . . don't they too become obsolete?

obsolete!

To avoid owning a *new* plant that is an antique *before* it starts up, be sure that you insist upon modern compressors.

Clark is the only source of MODERN compressors that are specifically designed and built as turbo-supercharged units.

This means high power output—up to 65% more, without cutting into overload capacity or safety factor. Furthermore, a 10–15% reduction in fuel consumption plus a 40% saving in cooling cost is a direct result of turbo-supercharging.

Though Clark Model TLA and TRA Turbo-Supercharged compressors are modern designs, they have already been proved in numerous installations. They are built in 1100–3400 BHP models.

If you would like further details on the advantages of buying MODERN turbo-supercharged compressors to match your other up-to-date equipment and facilities, call your nearest Clark office or write for bulletins No. 134 and 145.

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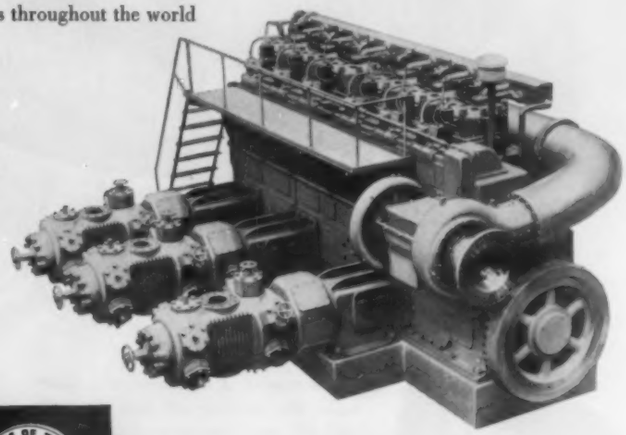
One of the Dresser Industries
Sales offices in principal cities throughout the world



Clark Model TLA-6 2000BHP Turbo-Supercharged, 2-cycle, gas-engine-driven compressor

CLARK®

Turbo-Supercharged Compressors

Cardwell's

There's a world of information in Cardwell's book, *"Slim Hole Facts with Data on Air Drilling."* 225 pages, covering Economic Considerations, Representative Drilling Programs, Drilling Techniques, Completion Techniques, Equipment Considerations including rigs, pumps, drill pipe, drill bits, and transportation charges, and an entire section on Air Drilling. This book is free to contractors and oil company executives. Write Philip L. McLaughlin, Director of Drilling Research, Cardwell Manufacturing Co., Inc., on your company letterhead.

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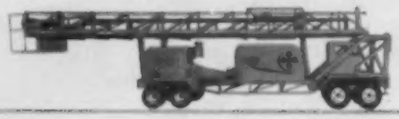
LEADS THE WAY TO

REDUCED DRILLING COSTS



30 years' experience . . . just the starting point for Cardwell's development of higher quality, more efficient rigs for Slim Hole drilling, "Big Hole" drilling, servicing, and workover operations.

Today . . . Cardwell's improved organization with wider resources and broader experience is directing its advanced planning toward your drilling and servicing problems in a determined effort to bring you new and improved rigs that will reduce your costs.

There's no limit to the advantages you can obtain with Cardwell equipment and world-wide service. Whatever your requirements, we invite you to "Call on Cardwell."

CARDWELL MANUFACTURING COMPANY • Box 2001—Wichita, Kansas, U. S. A.

How to increase California's recoverable oil reserves

We believe every citizen and taxpayer has a personal stake in the Oil and Gas Conservation Initiative

A huge increase in California's recoverable oil reserves will result from an oil conservation measure for which title has been approved by the Attorney General.

Prohibits Waste of a Vital California Resource

This initiative differs sharply from other oil measures brought before the public in the past. It does not permit market demand curtailment and pro-ration. It is designed solely to give the oil industry legal tools, to match its know-how, to carry out production practices necessary to enable the industry to be good stewards of California's oil reserves.

Insures continued high employment

It will enable a majority of the operators in a field to bring about practices which will prolong immeasurably the lives of fields in which they are employed, insure continuing employment to those in the industry far beyond present expectations, and provide a strong bulwark for the cornerstone represented by oil production that underlies California's whole economy.

Oil means three billion dollars in pocketbooks of Californians

The public welfare involved in good oil conservation is indicated by the fact that in 1954 the various petroleum products derived from California oil production added about three billion dollars of new wealth to the State.

For two years Richfield has conducted a public information program about oil.

As a public service and in our own self-interest, we have been telling the people of California how tremendous quantities of recoverable oil are being wasted by being left unrecovered in the ground.

Richfield engineers have told meetings of women's groups, community leaders and conservation groups how the physical waste of oil could be prevented, and the size of the public's stake in good oil conservation practices.

These meetings have always ended with strong expressions of support for action that would protect the public interest in this vital natural resource.

Public has demanded this constructive action

It is because of the very favorable public response to the information program that we decided to sponsor an initiative measure for an oil conservation law and bring the matter directly before the people.

Not enough new pools are being discovered in California to keep oil production equal to ever-increasing demand. We are now sending dollars abroad for the purchase of oil — dollars that would otherwise be circulated among our own people in payment for goods and services of all kinds.

Initiative provides only sure way to keep California's oil prosperity

There is one sure way to increase California's reserves of recoverable oil and thus assure California of continued prosperity. That way is unit operation in as many oil pools as possible. California producers need the law to facilitate unitization.

My associate, R. W. Ragland, and I are the sole sponsors of the initiative petition. But discussions which we have had recently with other oil people indicate that a majority of the industry will support the proposal.

We expect the measure to qualify for the general election ballot, November 6, 1956.

Chas. S. Jones

PRESIDENT...RICHFIELD OIL CORPORATION

from the heart of the South • serving the Nation & the World

Expansion does not only imply growth on a horizontal plane. It also implies extension vertically *. . . the improvement of the quality of Service, new and better facilities to serve every customer, large or small. Today, as Avondale serves the Nation and the World from its strategic location in the New Orleans area, the importance of* Vertical *growth has become more and more apparent to the many industries Avondale serves . . . the Oil Industry (particularly the fast-growing offshore drilling segment), the Marine Industry, the Chemical Industry, the U. S. Navy, U. S. Coast Guard, U. S. Army Engineers and many others. These satisfied customers know and appreciate that Avondale's expansion represents not only growth, but improvement—in every phase of Service!*

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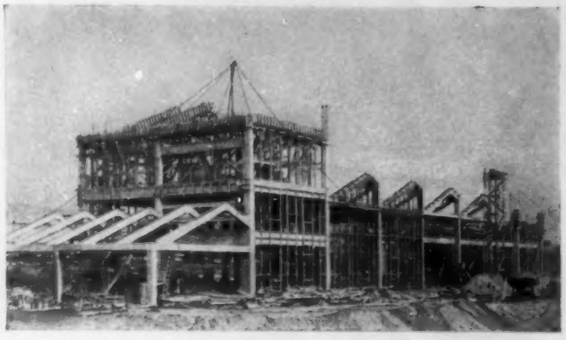

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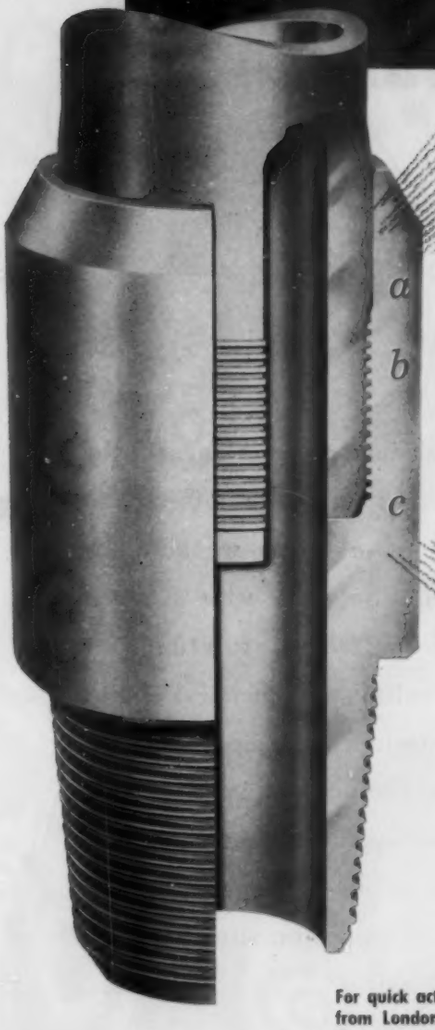
The Reed Super Shrink-Grip FIELD REPLACEABLE tool joint



protects your drilling string investment—against twist offs, against washouts, against leaks

BECAUSE: *a*. The Shrink-Grip "safety area" supports the drill pipe beyond the threaded section . . . and seals against leakage. *b*. Entire thread length is protected by seal at each end. *c*. Fixed landing shoulder assures proper make-up . . . and effects a seal.

extends your drilling string investment to drill "extra wells"

BECAUSE: The "field replaceable" feature of the Reed Super Shrink-Grip Tool Joint enables the operator to: 1. SAVE PIPE by reversing ends before excessive slip wear; 2. SAVE PIPE by replacing tool joint damaged by careless handling; 3. SAVE TOOL JOINT when pipe is bent or crushed; 4. SAVE PIPE when tool joints wear out after they have served their time in giving long trouble-free service.

For quick action in getting complete information . . . in oil areas served from London, write or wire Reed Roller Bit Company, Moorgate Hall, Moorgate, London E. C. 2, England. Cable Address "REEDBIT LONDON."

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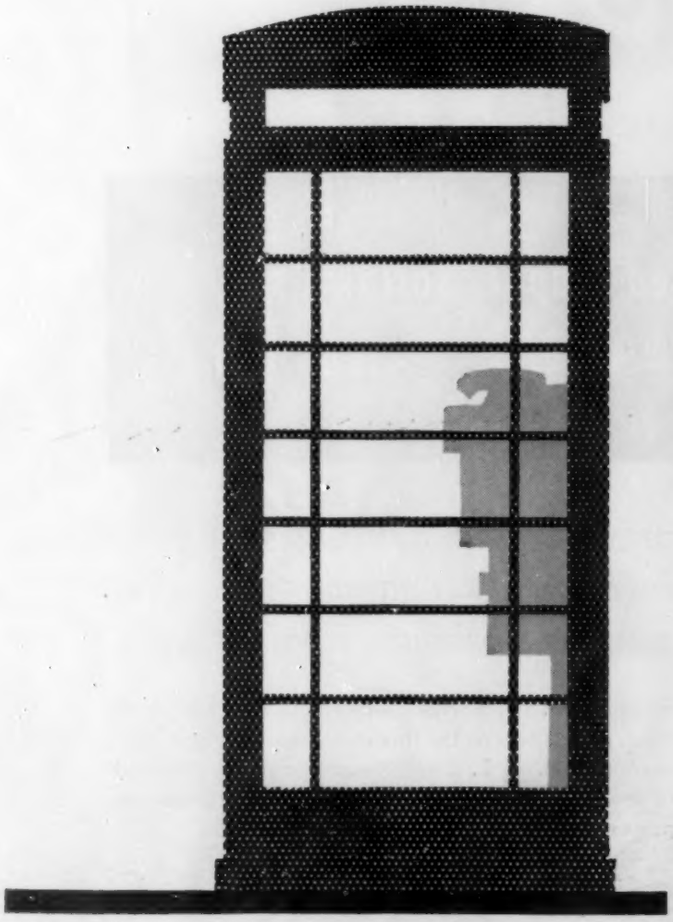

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The call box at your corner, the telephones in your office and home; these things we take for granted. So, too, with *Kenyon Planned Heat Insulation* for steam raising and chemical plants, which includes technical advice on thermal insulation specifications and finishes for all conditions, the supply of materials, application and supervision on sites throughout the world.

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and with Davison's *LOW DENSITY* catalyst you get commercially proven higher stability. You get a higher degree of thermal stability without affecting the resistance to attrition or other proven qualities of Davison catalysts. Commercial fluid cracking units, operating for over one year, demonstrate that this stability leads to:

Higher surface area—Higher pore volume—Higher pore diameter—Higher catalytic activity—Improved regeneration

This new *LOW DENSITY* catalyst is yet another Davison catalyst manufactured with controlled catalyst characteristics. At Davison you can get the catalyst best suited for your unit. For information on Davison's new *LOW DENSITY* catalyst, as well as other Davison catalysts, see your Davison representative or write.

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The services of our technical specialists are available to assist you in the design, installation and operation of a Unicor system of protection. Write us for samples and information.

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UNIVERSAL OIL PRODUCTS COMPANY

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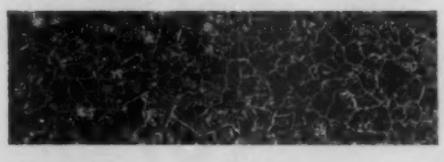
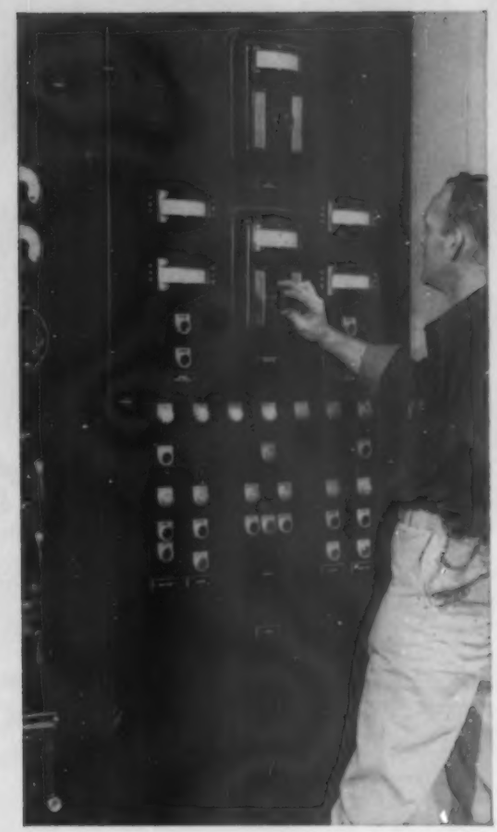
He stirs molten steel by magnetic control to help give TIMKEN® forging steels



uniform grain size



WITH the mere turn of a dial, the man pictured here stirs molten steel in one of our huge electric furnaces. He's controlling a magnetic stirrer that assures equal distribution of alloys, uniform temperature and improved working of the slag . . . one of the quality control operations that helps give uniformity to every bar of Timken® forging steel.

Conventional stirring is done manually with a long stirring rod. This new method does it with a travelling magnetic field set up by coils under the furnace. It's the first installation of its type in the United States. And it's another example of the Timken Company's continual search for equipment that will improve steel quality and keep it uniform.

For instance, note the uniform grain size of Timken forging steel in the photomicrograph above. We use the most modern steel-making techniques known to get this uniformity in our steel. And we examine every heat to be sure it's there. Result: you can be sure that your forgings made from this steel have uniformly high ductility and resistance to impact.

To further assure uniformity in your forgings, fewer changes in your forging procedures, your order of Timken forging steel is handled *individually.* This allows us to target our conditioning procedures to your end use requirements. In every lot you order, you get the same physical and chemical properties that you require—bar to bar, heat to heat, order to order. And helping to lower your production costs, the close dimensional tolerances of Timken forging steels produce uniform weight multiples with a minimum of steel lost in flashings, saving you steel. To get all these results in your forgings, always specify Timken forging steels. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

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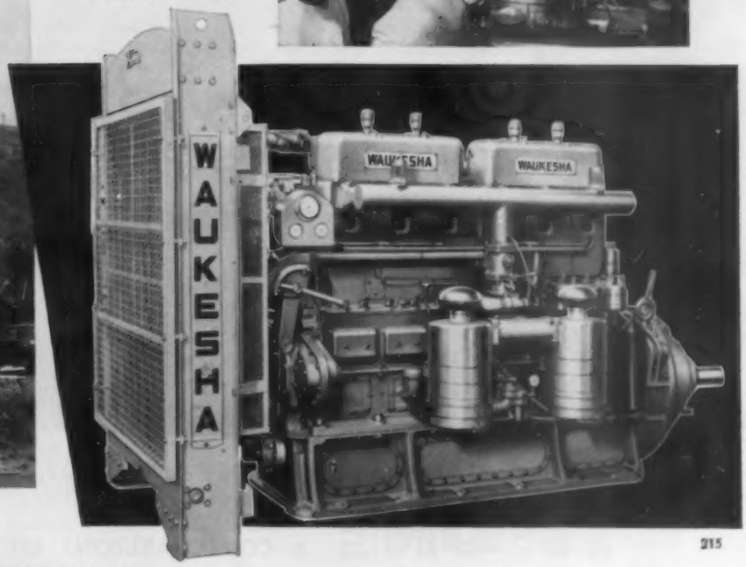
WILSON *Powers* BIGGEST RIG with Model 6-LRZU WAUKESHA

It's the biggest Wilson rig operating today! Built for San Joaquin Drilling Co., California . . . for the deepest drilling . . . down, down, below 20,000 ft. This new Wilson Super Titan Model Torcair rig has tremendous power, with its three Model 6-LRZU Waukeshas—the power plants of proved performance and deeper drilling dependability. Versatile for varying loads—they put out the plus power promptly, and smoothly as needed. For features: Bulletin 1481.

San Joaquin Drilling Company on location: Wilson Super Titan Model Torcair rig has three WAUKESHA 6-LRZU Big Gas power units (rig as designed can use five units).

WAUKESHA 6-LRZU Big Gas Power Unit 6-cyl., 9⅜-in. x 8½-in.; 3520 cu. in. displ.



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SHELL Launches New Safety Series

All over the country people are seeing Shell Better Driving Quizzes like the one on the right and those below.

Behind this new campaign lies Shell's conviction that part of our job—as a major supplier of gasoline and oil products—is to promote driving safety. That's why Shell started the famous "Share-the-Road" club back in the late 1930's. That's why we established the Carol Lane Awards for women's efforts toward traffic safety.

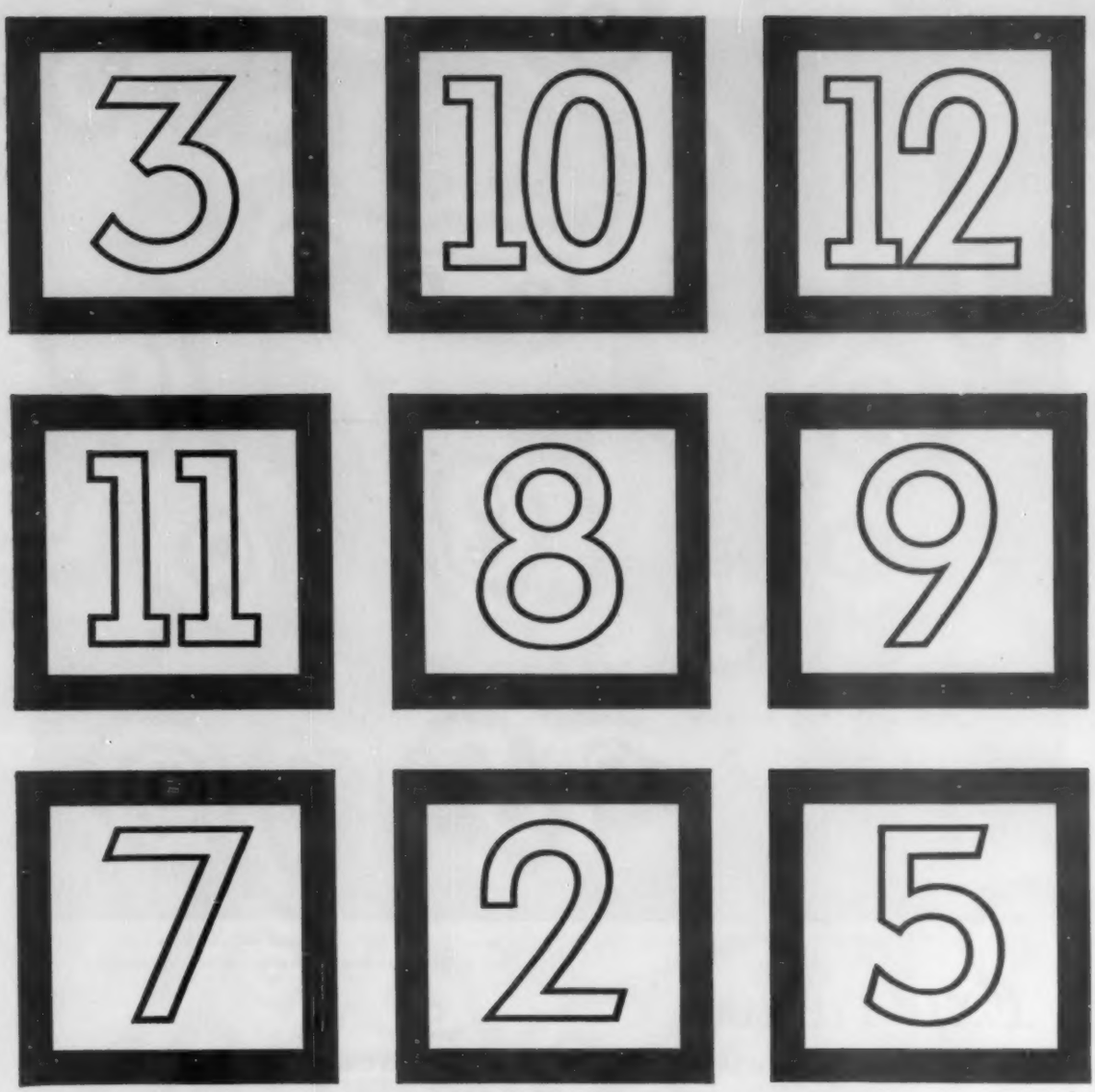
This new safety series urges the reader to test his reflexes, eyesight, knowledge of road signs, driving attitudes. No longer can the reader shrug off a safety message as written for "the other fellow." First indications are that these advertisements actually are helping many drivers think more seriously of their highway habits. That's a sure sign of a better future for all of us.

Can you tell a road sign by its shape?
Read and obey your signs of life!
SHELL OIL COMPANY
How far from the car in front should you be at 50 mph?
Stay Back! Don't Crowd Your Luck!
SHELL OIL COMPANY
PUT YOUR FOOT ON THE GAS PEDAL HERE.
See how fast you can move to the brake!
BRAKE
GAS
SHELL OIL COMPANY
Check your driving attitudes
STOP
Drive right...enjoy your right to drive
SHELL OIL COMPANY

TRY THIS BETTER DRIVING QUIZ!

It helps you relate your reaction time to safe driving speeds. Others in Shell's public service series on driving safety highlight such factors as courteous attitudes and recognition of road signs.

SHELL



HOW FAST CAN YOU TOUCH EACH SQUARE IN NUMERICAL ORDER?

WITHIN 9 SECONDS? Your reflexes are about average.
WITHIN 7 SECONDS? Very good.
WITHIN 5 SECONDS? Excellent.

MORE THAN 9 SECONDS? YOUR REFLEXES ARE TOO SLOW. DON'T DRIVE OVER 45 M.P.H.*

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*Authority Dr. Herbert J. Stack, Director, Center for Safety Education, New York University

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The unit shown in the photograph, recently completed for a South American refiner, is but one of the 17 alkylation units designed and constructed by Foster Wheeler. This cumulative experience is available to refiners everywhere — for evaluating the economics of the process and undertaking full responsibility for plant design and construction. For complete information, write to *Foster Wheeler Corporation, 165 Broadway, New York 6, N.Y.*

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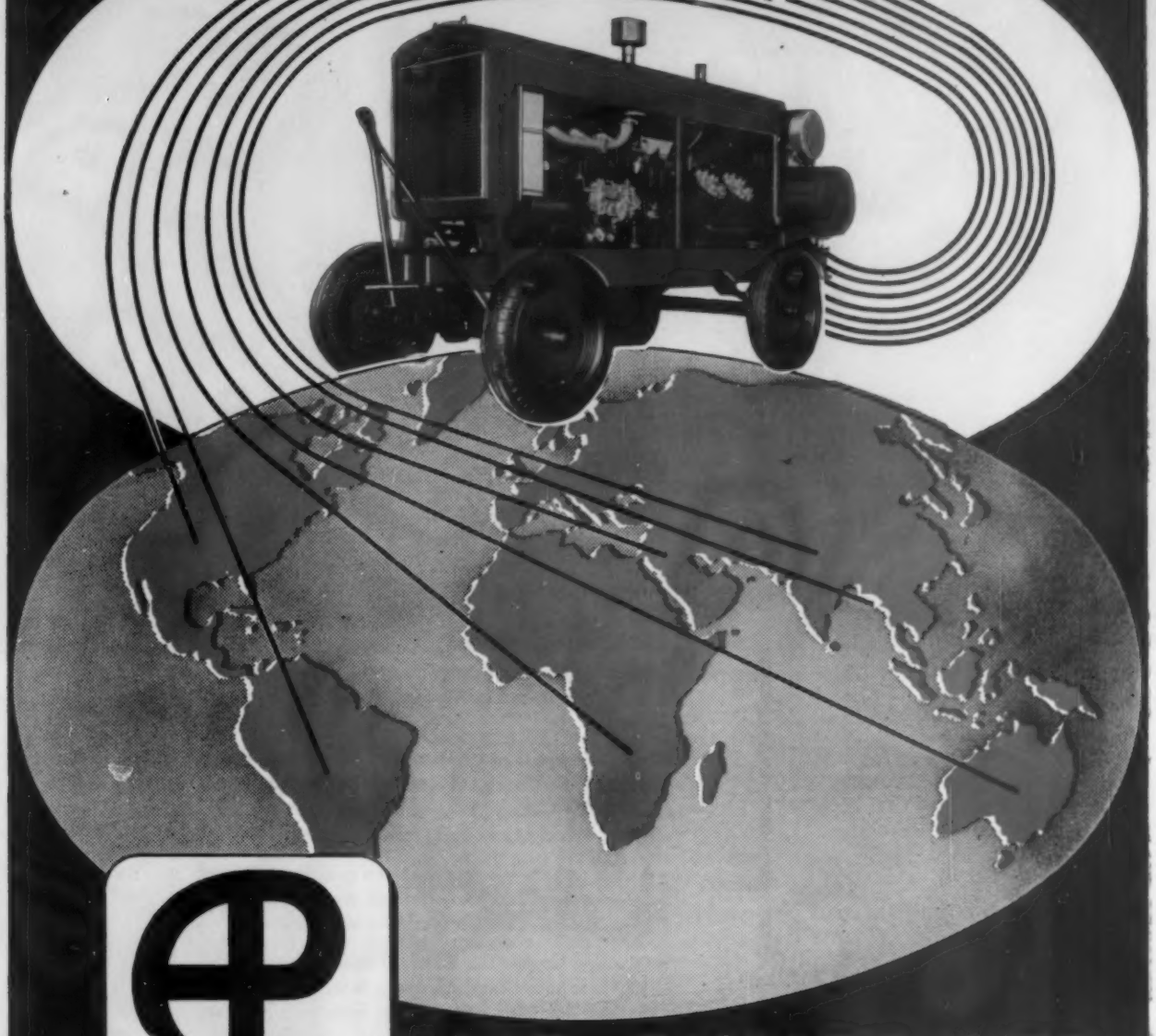

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Oldest educational program on the air, the Standard School Broadcast today features a symphony orchestra, conducted by Carmen Dragon, together with choral groups, a dramatic cast and famous guest soloists.

Its goal is to help Western children gain an absorbing new interest in music, and—through music—a broader understanding and knowledge of the world around them.

You'll enjoy hearing the Standard School Broadcast's fine music at home...and discussing it with your children to give you one more valuable link with their interests.

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This treatment packs a one-two punch

Fracturing and acidizing at the same time, Acid Petrofrac* delivers a two-way attack. Excellent sand-carrying properties permit deep penetration, while the high acid content dissolves soluble portions of the formation. The result . . . increased permeability.

Experienced Dowell engineers tailor each treatment after considering well and formation characteristics. This means greater production return for your well investment dollar. Get the fine service that this investment deserves. Call Dowell for your next well.

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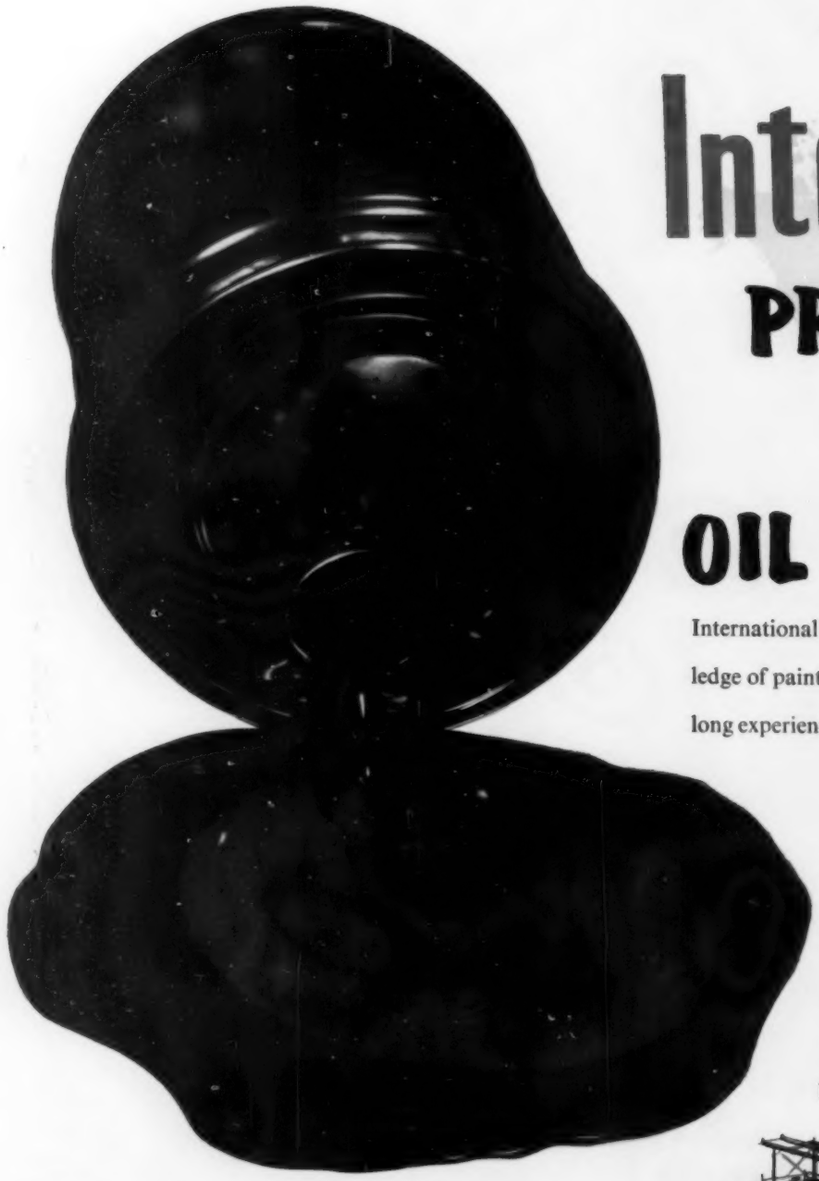


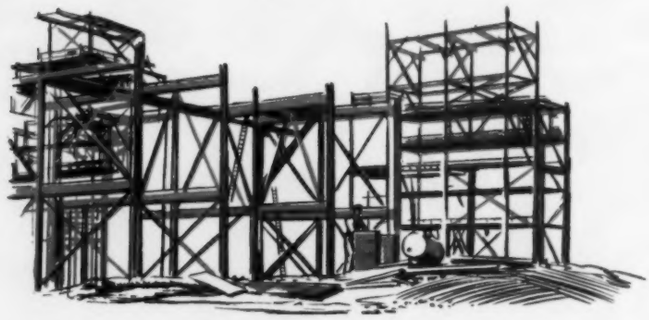
International

PROTECTION for the OIL INDUSTRY

International is a world-wide paint organisation with expert knowledge of paints for the oil industry. This knowledge is derived from long experience of the industry's special requirements and problems.

INTERNATIONAL RED LEAD GRAPHITE PRIMER

Made from genuine red lead and selected graphite. The leafing effect of the graphite pigment makes this primer dry with an exceptionally strong film of uniform thickness. This means that structural steelwork, storage tanks, gasholders, etc. can be properly painted even by semi-skilled labour.



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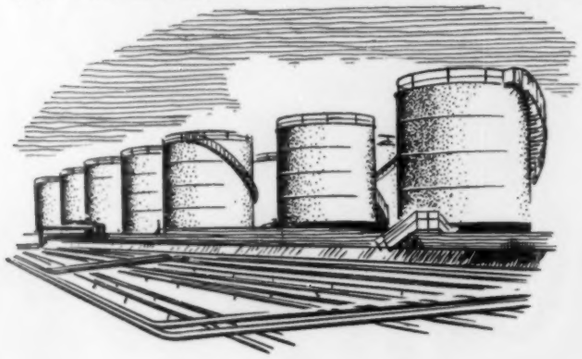

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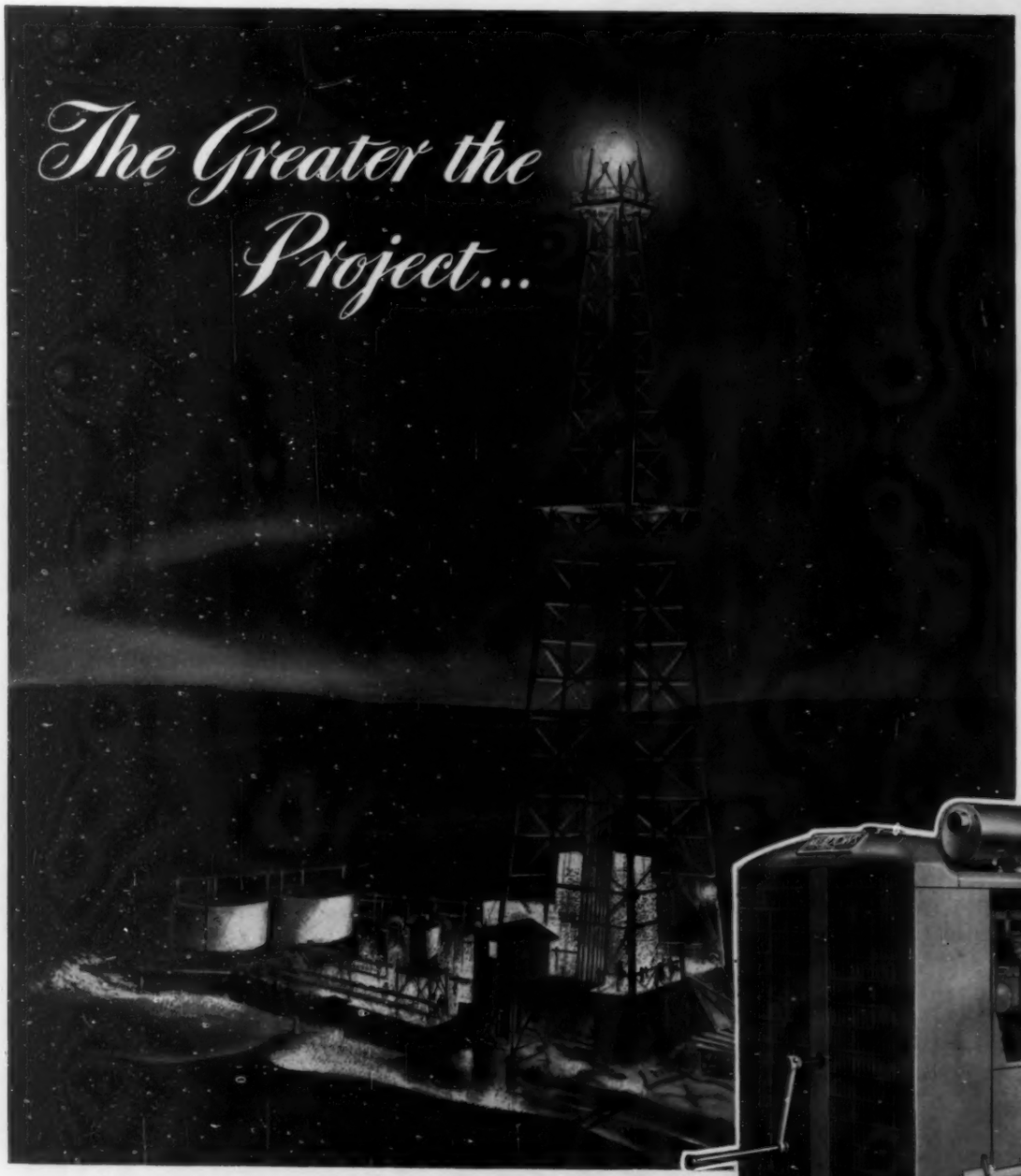

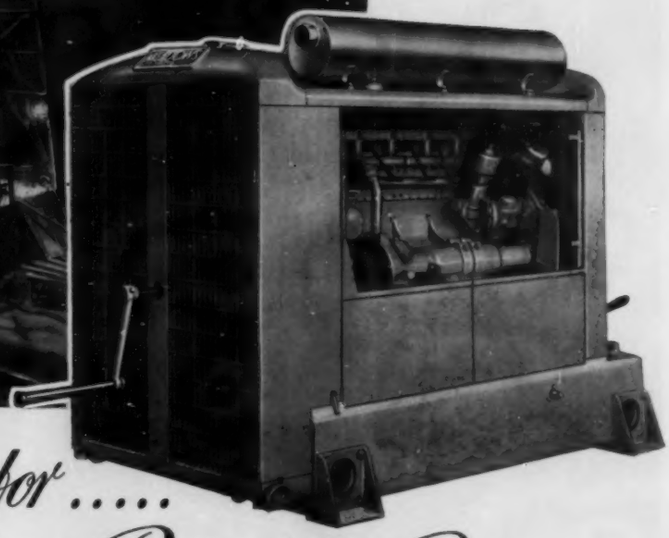

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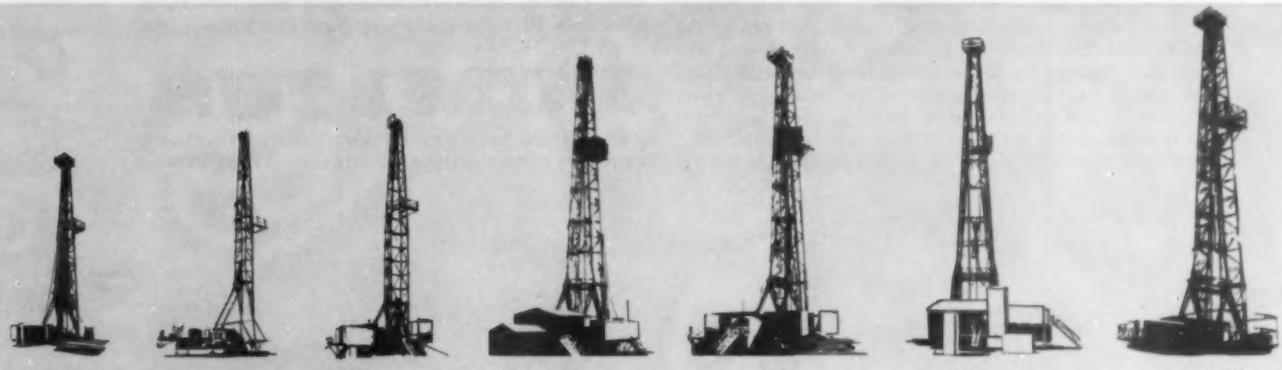

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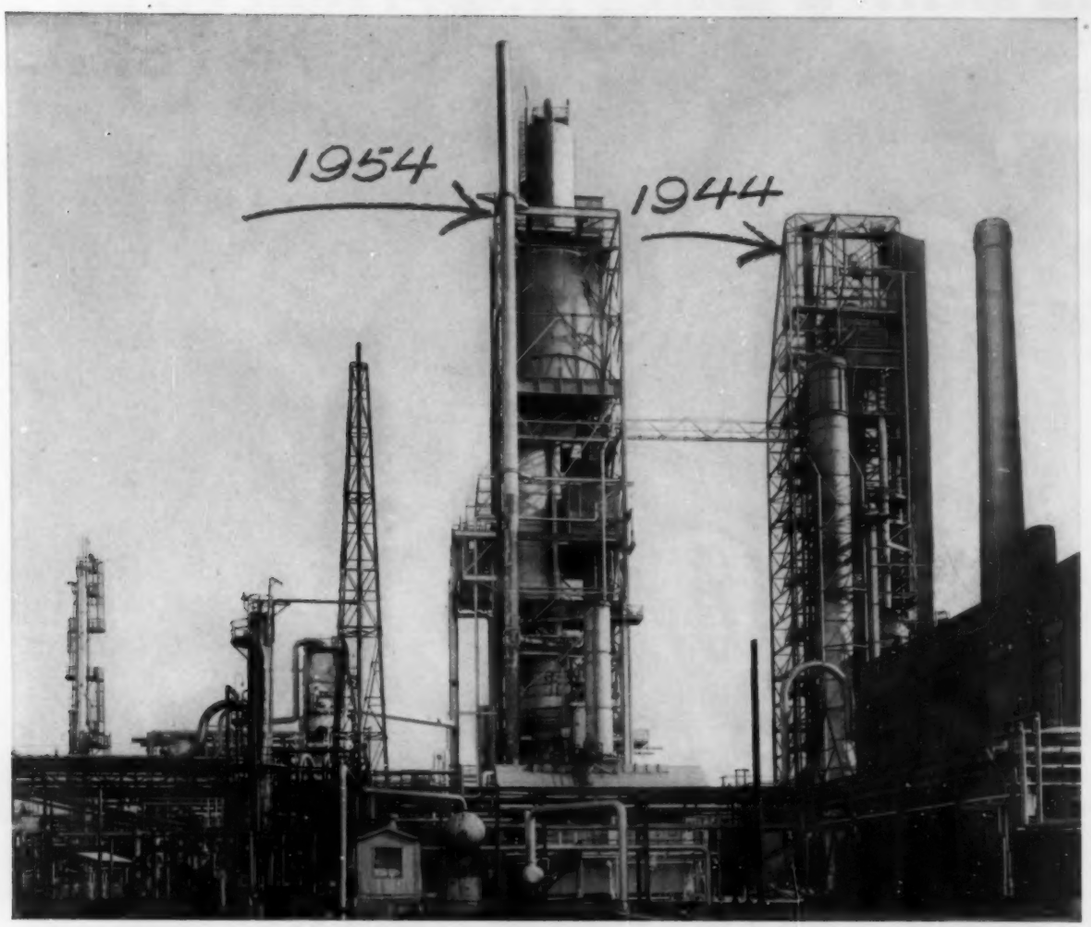

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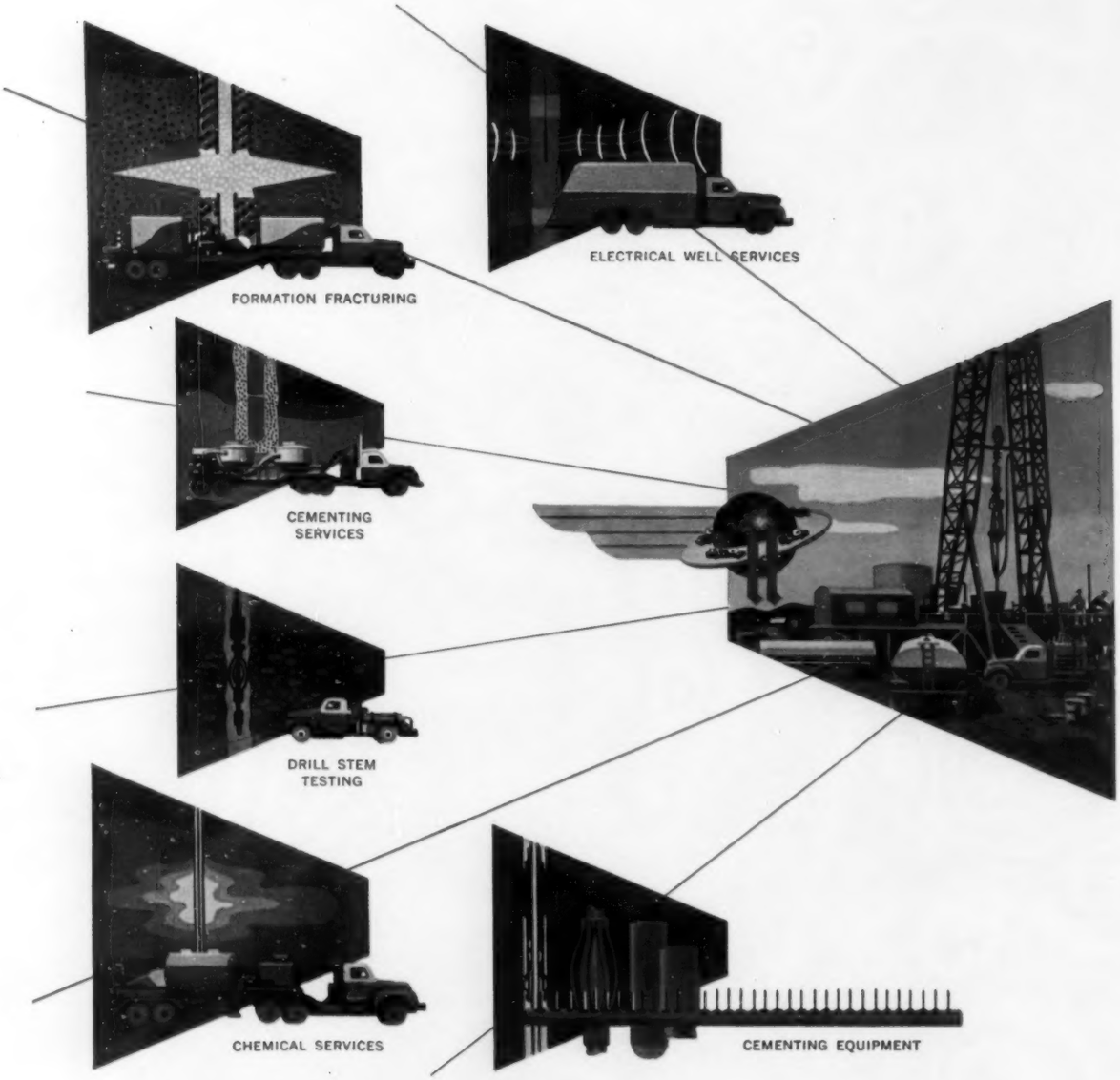

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Marine Field Faces Vast Expansion

A MOST notable feature of the past year in the American petroleum industry was the movement toward a vast expansion in marine drilling activity. In the language of the petroleum world "big money" has moved into the field in a big way, which means that most of the major companies of the United States have committed themselves to the expenditure of billions of dollars in testing offshore waters for deposits of oil, gas and minerals known to lie beneath them. Inasmuch as hundreds of millions have been spent in bringing progress in this branch of activity up to its present point it may be considered that a fairly big investment already has been made, but this will be multiplied during the next few years as the testing of recently acquired leaseholds proceeds.

While petroleum production from offshore areas in the Gulf of Mexico has been going on for a decade and a half and during that time some 800 wells have been drilled, the way to systematic exploration and development of underwater resources was opened by the action of Congress in 1953 in defining the relative jurisdiction of the state and federal governments, assigning to the latter control over the section designated as the Continental Shelf, which comprises much the larger area, and leaving to the former jurisdiction of the waters adjoining their respective shores.

Most significant evidence of the confidence of the oil industry in the existence of great oil reservoirs in the Gulf and of the readiness of its members to risk huge sums in determining the location and extent of these deposits was afforded by the surprisingly high bonuses paid for leases offered to competitive bidding. These bonuses, it should be borne in mind, convey no title to the sites but only the right to conduct operations for a specified time in the particular spots fancied by the bidders.

Following the tidelands legislation of Congress, the Interior Department in Washington had mapped two million acres in the Continental Shelf area for offering on this basis in a series of sales, while the States of Louisiana and Texas held similar auctions of tracts in waters under their authority. In a sale by the State of Louisiana shortly after the end of World War II, where the bonus plan was applied, the average bid was a little over five dollars per acre, while in the three sales held by the federal government, the average for the 235,000 acres disposed of was over $1,000 an acre while premiums upward of a million dollars were paid for a considerable number of single tracts. Altogether, the bonus take of the three government agencies has amounted to roundly $400 million.

This is a substantial outlay as a first step, but it is not all. A yearly rental of three dollars per acre is charged by the federal government and the first year's rental must accompany the lease bid. If oil is found, a royalty of one-sixth must be paid. Leases run for five years and with that limitation facing them, holders will proceed with all speed possible to conduct their tests. This insures a high degree of activity in Gulf drilling on lately acquired leases, in addition to the extension of existing fields, which at the present time have a daily production of over 62,000 barrels off Louisiana alone.

During the past several years, as exploration and drilling has steadily progressed in offshore waters within the limits definitely reserved to the states, a great deal of valuable experience has been gained in the development of methods and techniques adapted to marine operations, which differ in many respects from those employed in land drilling. Some reductions in costs have been effected, but the investment required for each marine installation still remains from two to five times as great as is necessary for land bases and usually exceeds a million dollars without including facilities for transportation of oil that may be found.

Two factors are responsible for the willingness of oil operators to risk huge sums in the test of offshore areas. One is the confidence based on what already has been accomplished and on the favorable indications established by geological surveys that some very large fields may be located in the areas that are being submitted to public offering. The other is the hope that the addition of great reserves of petroleum will provide much needed insurance for the demands of the future.

The experienced oil men who are to undertake the task of conducting this search and providing the collosal sums which it will require are agreed that unless fields of large extent are discovered, the development of marine production on a sound economic basis will be impossible, at least until oil commands a much higher price than at present. A big field in oil industry terms is one with a potential yield ranging upward from 50,000,000 barrels. Anything less than that in offshore exploration with present costs and prices, they hold, could not repay the investment put into it.

(Continued on page 130)

Entry of independent operators into exploration activity in wildcat areas outside the United States has helped raise 1956 geophysical reconnaissance operations to a high level. Wildcat drilling operations began the year at ten percent above 1955. Cuba, Central America, Africa and Turkey are areas of unusual exploratory activity.

Record world exploration in 1956

Rainy period in Nigeria. In background is one of the helicopters which are being used for transport of personnel and important communications. (Photo courtesy of Shell Oil Co.)

Oil exploration activity in 1956 will exceed the record levels of 1955. Rotary rigs operating in the free world were 10% higher in January than a year ago and geological and geophysical reconnaissance activity also was at a new high.

The sparkplug in this exploratory drive is the large increase in consumption which has sent oil companies searching in new and old areas around the world for additions to reserves. A recent survey by Joseph E. Pogue and Kenneth E. Hill of the Chase Manhattan Bank, New York, indicated that consumption of petroleum in the free world will reach 24.8 million barrels daily by 1965, a 71% increase over 1955. By that time foreign demand outside the United States and the Soviet nations is expected to average 12 million barrels daily, nearly as much as U.S. demand.

The Chase report estimated that to meet the increase in consumption over 10 years, the industry must spend $66.6 billion for exploration and production. To the individual company, as the head of a major oil concern pointed out, each barrel of oil found and marketed represents an investment of about $4,000, using a world-wide average.

The size and risks involved in hunting new oil has not slowed down exploration. Last year was marked by the increased number of independent companies which joined in the oil search outside the United States. Two regions, Central America and Africa, received an unusual amount of attention and six countries, Guatemala, Bolivia, Colombia, Libya, France and Turkey, eased restrictions on foreign exploration. Oil companies generally were attracted to foreign exploration by the diminishing chances of a major new oil strike in the U.S. and lower finding costs per barrel in areas outside the U.S.

Africa and the Middle East

Africa—The greatest increase in exploration occurred in Africa. Encouraging discoveries or shows were encountered in Algeria, Egypt, Angola, Gabon and the French Cameroons.

Exploration in French North Africa was held back by political disorders. Nevertheless a total of 330,000 feet of hole were drilled in the non-Sahara or northern part during the year, and 125,000 feet were drilled in the Sahara. Algeria contributed the best possibilities with encouraging shows by CREPS, a company owned 35% by the Shell Group and the remainder by the Algerian and French Governments. The company had three wells drilling at the year's end. One well just east of Fort Flatters in the extreme southeast of Algeria, reported encouraging oil shows. This area is near the Libyan border and the well results could have an important effect on developments there. Standard Oil (N.J.) reportedly has a Libyan concession only about a mile away.

The other two countries of French North Africa showed little encouragement for the explorer. In French Morocco no new discoveries have been reported since the Lower Bled Khatara field in 1954. A good stepout well, 1½ miles from this field, was brought in in 1955 with about 6,000 b/d from 5,570 feet known as Zrar 6. The field has been already limited to the north and south, however. The Societe Cherifienne des Petroles (SCP) has been the sole operator in the country until recently, when a new company, Petromines, was reported to have taken out exploration permits covering about 46,930 acres in the valley of Oued Beth, about 18 miles south of Lower Bled Khatara.

In Angola the Companhia de Combustiveis do Lobitos Purfina continued drilling on its discovery on the Benfica structure 13 miles south of Luanda. An arrangement was made with the Portuguese government for establishment of a new company to own the discovery with stock held 33-1/3% by the province, 33-1/3% by the parent company, Compagnie Financiere Belge des Petroles, S.A., "Petrofina," 11-2/3% by the Cia. de Combustiveis do Lobitos Purfina, 11-2/3% by the general public in Portugal and 10% by friendly Portuguese groups.

The original discovery during early 1955 was reported to have flowed at 360 b/d from 8,400 feet. Four wells have been drilled to date on the structure, but production problems were reported to be unsolved as yet, involving the use of high pressure acid injection and the wells are presently awaiting arrival of equipment. Oil produced to date was reported to have been sweet, high gravity crude. The company appears optimistic about the discovery. The government granted permission to build a refinery based on production, to be operated by the exploration company.

In British Somaliland, Standard-Vacuum and associated companies has begun studies of a 12,000 square mile exploration tract obtained from Moriqui Exploration Corp. of Los Angeles. Conorada has a 36,000 square mile concession where drilling may soon be in progress. Standard Vacuum has two parties working, one geological and one gravity magnetometer. Activities in this area, which has the only oil seep in northeast Africa, will cease during the summer due to the heat.

In Egypt considerable exploration work is in progress, following the passage of the 1953 petroleum law. The principal exploratory development of 1955 was the discovery of a second pay in the Lower Miocene on the prolific Belayim structure by International Egyptian Oil Co. A discovery in late 1955 extended this field about three and one-half miles south with Belayim 113-1 well which came in from Miocene at 8,130 to 8,265 feet.

International Egyptian is owned by Petrofina, a Swiss group, AGIP, Mineraria, and Italian government company, and Southern California Petroleum Corp. This company took over the 1949 Wadi-el-Feiran discovery of Standard Oil Co. (N.J.) and has since developed substantial production.

Gravity and seismic parties of The Shell D'Arcy Petroleum Co. Ltd. are making preliminary surveys in the Eastern Region and a test well is being drilled in the Owerri region of Nigeria. Picture shows bridges being reinforced for heavy loads. For this work roads are closed for a day while reinforcing piles are driven into the river bed. (Photo courtesy of Shell Oil Co.).

The other major exploratory development was the entry of Conorada Petroleum Corp. representing Ohio and Continental, into the Western Desert with a concession covering about 72,000 square miles. Richfield and Cities Service obtained a concession over 14,000 square miles immediately east of the Conorada concession and the companies pooled their interests. Sahara Petroleum Co. is in charge of operations for the group. An exploratory well, Burg-el-Arab, was spudded in 1955 in the Western Desert 28 miles southwest of Alexandria. The well was drilled to over 9,000 feet, at which depth it was in Jurassic limestones. Several highly porous sand members were penetrated in the Cretaceous, but all were water logged. No commercial shows were reported, despite optimism in several government press releases. A second well is to be begun with the area of the Cities Service and Richfield original concession area where the latter two companies retain control through ownership of shares. A third rig was brought in during early 1956.

In Ethiopia Sinclair Oil Corp., jointly with Conorada Petroleum, has carried out an extensive program of exploration which

extends back over eight years. It includes aerial reconnaissance and geophoto studies, airborne magnetometer and gravity surveys, the latter in the Gumboro, Galadi and Jim Ali districts. Refraction seismics were carried out previously on about 90 square miles of Jim Ali and a similar area in Galadi, with additional work done on about 1,200 square miles in the Gumboro Hills and Galadi.

Operations have been concentrated in the Ogaden area of southeastern Ethiopia and two test wells have been drilled. During 1955 six stratigraphic tests were drilled with a combined total depth of 27,456 feet and there are two drilling at present. Heavy rigs have been stacked pending accumulation of more information and there are only two light rigs operating now. Company officials say it is too early to give a final opinion on the area's prospects.

In French Equatorial Africa two strikes were reported. One was by the Societe des Petroles d'Afrique Equatoriale Francaise, which continued gravity and seismic work on its 28.7 million acre concessions in Gabon, and during mid-December of 1955 reportedly struck about 50 b/d of oil near Port Gentil on the coast. Depth reported was 3,600 feet and the field was described by company officials as small, although producing equipment was reportedly being brought in. Port Gentil is near the mouth of the Ogooue River on Africa's west coast. Total drilling by the company during December 1955 was about 6,400 feet.

The second discovery in French Equatorial Africa was in the Cameroons. During January 1956 the Societe de Recherches et d'Exploitation des Petroles du Cameroon reportedly discovered 1,400 b/d production at 8,200 feet. This company had drilled 750 feet during the last month of 1955. More than 20 wells have been drilled on its 3,474 square miles concession.

In Gambia, part of French West Africa, D'Arcy Exploration Co., a subsidiary of British Petroleum, has undertaken a waterborne seismic survey, expected to cover about 200 square miles and to last about the first three months of 1956.

Gulf Oil Corp. is reportedly negotiating with the British government for a concession in the Gold Coast.

In Italian Somaliland, where Sinclair holds a concession covering about 70% of the country, including that adjacent to its Ethiopian concession, two seismic crews were operating during 1955, and three are operating at present. Drilling may begin in May, 1956.

In Libya no geophysical or drilling work has been done by American companies pending final allocations of concessions. Some work has been done in previous years by British and French companies. Among the 13 companies that received concession allocations are: the Compagnie Francaise des Petroles, Mobil Oil Co. of Canada Ltd. (the Canadian subsidiary of Socony Mobil), Esso Standard of Libya, Inc., Anglo Saxon Petroleum Co. (Shell), D'Arcy Exploration Co. Ltd. (British Petroleum), Nelson Bunker Hunt Oils Ltd. (Bunker Hunt interests), Tapco-Calasiatic (owned by Texas and California Standard companies), Libyan American Oil Co. (Texas Gulf Producing Co.) and Conorada Petroleum Corp. (owned by Continental Oil Co., Ohio Oil Co. and Amerada Petroleum Co.). The applications covered the coastline completely, with four located on the Algerian-Tunisian borders and one on the border of Egypt (owned by Conorada). Only two companies, Libyan American and Esso, had concessions in the far south or Fezzan. Active exploration will begin in 1956.

In Madagascar the Societe des Petroles de Madagascar has continued exploration on the 48.9 million acre concession now held. Seismic and gravity work are being performed in Sikily Valley, and in Andranomalio, Ankazoabo and Sakarama regions, as well as in the sector north of Mongoky. Recent drilling revealed some gas in the Sikily Valley.

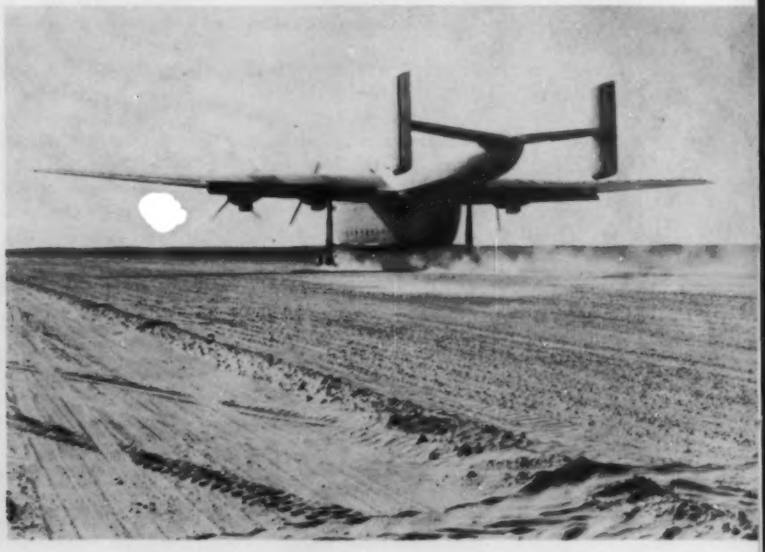
Toward the end of 1955 a well was drilled by the company about 220 kilometers northeast of Tulear on the Ambalabe structure. No shows of oil or gas were reported.

In Mozambique the Mozambique Gulf Oil Co. has reportedly conducted some surface work but no drilling since the original two dry exploratory wells completed during 1952 and 1953. The drilling rig used at that time was shipped to Sicily. Gulf holds a concession granted in 1948 covering a large part of the country which gave a three year period for definition of the area, with a four year exploration term plus a five year extension, subject to sufficient work being performed thereon. Drilling will be resumed during 1956 with one rig.

In Nigeria Shell-D'Arcy Petroleum Development Co. of Nigeria Ltd., owned by British Petroleum and Royal Dutch/Shell continues its exploration effort which now includes 11 wells with no commercial production to date, over an 18-year period. The company has an exploration license over about 14,000 square miles, plus 12 exploration licenses of about 2,000 square miles each. An American company recently became interested in Nigeria when a Socony Mobil subsidiary received exploration rights over the northern two-thirds of the

The Jebel Fahud wildcat is located on a well-defined structure in the Rub al-Kahli or Empty Quarter of southern Arabia. A partial view of the structure is shown above.

About 1,000 tons of equipment were flown into the Jebel Fahud wildcat. Picture shows cargo plane arriving at the well.



country. Shell's interests are primarily in the southeastern section.

In Tunisia exploration has continued by SEREPT (Societe de Recherches et d'Exploitation des Petroles en Tunisie) which is owned by the BRP and the Tunisian Government. This company achieved its best results to date in the earlier discovery of gas at Cap Bon which is now being piped to Tunis, but has not had any discoveries since, although four geophysical crews were operating at the beginning of 1956 and an aerial survey was made in 1955. SNAP, 30% of which was owned by Gulf, has withdrawn from Tunisia and there is only one other company remaining, the Compagnie des Petroles de Tunisie (CPDT), owned 65% by Shell. This company has two Ideal 50 rigs and one 100 working. No commercial discovery has been reported to date.

A wildcat by D'Arcy Shell Petroleum Development on Mafia Island off Tanganyika was abandoned at 11,051 feet in early 1956. No shows were reported and equipment was moved to Zanzibar for drilling there.

Middle East—Exploration activity in the Middle East included several exploratory wells, of which one in Kuwait appeared to be an important discovery. Drilling in Iraq, the Trucial Coast and Kuwait are covered under the Middle East article in this issue. In the latter country, Kuwait, offshore areas were opened for concession bids for the first time.

Substantial revision of Middle Eastern reserve figures were made during 1955 by Wallace E. Pratt in the McKinney report on peaceful use of atomic energy. His figures showed a total of 230 billion barrels proved reserves for the Middle East, a large increase over previous industry figures.

Israel became an oil producer during 1955 with the discovery in September 1955 of 30.5° API gravity oil at 4,906 feet by the Lapidot-Israel Petroleum Co. The discovery was made while deepening an old well abandoned for political reasons by Iraq Petroleum Co. during 1954. On deepening the well still farther a second pay was found at 4,946 feet of about 16 feet of oil-bearing formation. Production levels were about 420 b/d from the lower formation only, the upper was not tested. The discovery, together with the favorable oil law which was passed in 1952, has stimulated work in the area. The only other company which has obtained substantial shows is Israel American Oil Corp., owned by the New York investment firm of Bear, Stearns and Co. and the Husky Oil Co. This company found a show of gas at 660 feet on its Petah Tiqva concession in January of 1955; and later found gas at 3,000 feet in the Gan Yavne coastal strip.

Other exploratory developments in the Middle East included several exploratory wells and new concessions. British Petroleum received an exploration concession over the Aden Government's Kamaran Islands and their territorial waters in 1955. Gravity and magnetic surveys are reportedly beginning over the land areas, which comprise about 22 square miles.

An exploratory well, actually more of a stratigraphic test, was drilled in the Dhofar territory of Muscat and Oman during 1955. Dhofar-Cities Service Co., a subsidiary of Cities Service, began Dauka No. 1 on a concession held jointly with Richfield Oil Corp. The well was drilled to about 11,500 feet with no commercial shows, but a large sedimentary section. A new well will be drilled in March about 75 miles east and slightly south of Dauka No. 1.

In Iran exploration has begun by the Consortium with geological and geophysical surveys, supplemented by a geological party for exploration in Khuzistan in the second half of 1956. The government's National Iranian Oil Co. has planned a wildcat

The Jebel Fahud rig is shown above. The crew is sliding the rear half of the drawworks from a truck to the earth ramp in front of the well.

Transport of equipment and supplies is a major obstacle. The picture shows fuel being unloaded and floated ashore in the shallow water at Ras Duqm for transport inland.

This picture shows a Bristol freighter aircraft being loaded at Umm Said with parts of the Supalite camp for the Jebel Fahud wildcat.

Drilling is being done in Nigeria following aerial surveys, and geological, seismic gravimetric and core drilling exploration by The Shell-D'Arcy Petroleum Development Company of Nigeria Ltd. (jointly owned by a Shell company and B P). Aerial photographs for new maps of Nigeria are shown being laid out to form large sections before tracings are made. (Photo courtesy of Shell Oil Co.)

A survey team passing through Harisuku village near Kuru, Papua where British Petroleum with American and Australian interests are drilling an exploratory well. (Photo courtesy of British Petroleum Co.)

Shown is D'Arcy Exploration Company's Chalinzi drilling location situated approximately 64 miles west of Dar-es-Salaam, Tanganyika. The D'Arcy Exploration Co. is the prospecting company of the BP group. (Photo courtesy of British Petroleum Co.)

in the Qum region, far north of the Consortium concession area during 1956. The consortium has an independent contractor, Santa Fe Drilling Co., working on two wells in Aga Jari field which will drill two exploratory wells in Ahwaz, both of which are completions of wells begun before nationalization.

Activities in offshore areas of Bahrain were curtailed by boundary questions, but some offshore drilling in the Fasht Adhem area has been done between Bahrain and Qatar. No production from this exploratory drilling was reported.

In Iraq the Jambur field, recently tied into Kirkuk pipe line, was producing about 10,000 b/d. Exploration in other areas of Iraq held by IPC, including Mosul and Basrah, is being conducted with about two seismic parties in each area, as covered elsewhere in this issue.

An exploration concession contract was signed between Edwin W. Pauley, and the government, covering the entire area of Jordan during 1955. The concession provides for an eight-month period to select one-third of the country for exploration, following which a rig must be installed and drilling within 90 days. The contract calls for 50-50 profits split and a 10-year limit on exploration if production is not found.

A proposed law granting a concession to the Cie Libanaise des Petroles for exploration and development in Lebanon was reported to have passed the House of Deputies during 1955. The company is a local concern. It was formerly associated with Pacific Western Oil Co.

In Saudi Arabia at the end of 1955 three structure drilling, three seismic parties, one surface mapping and one gravity party were operating. In the Rub' al-Khali or Empty Quarter, one seismic party operated during 1955 in the central part while a structural drilling party with two rigs operated in the western and southwestern areas. A Shoran position-control survey was used to complete a photographic survey of the southern Rub 'al-Khali.

Two structural drilling parties were active in the northwest area of Aramco's concession, where one structure well was drilled to about 5,000 feet. In the area known as the Gravel Plains a seismic party worked the first half of 1955 and two structural drilling parties during the remainder of the year, one drilling a deep stratigraphic test. A seismic party operated around known fields, determining extension of same and doing a survey in northern Abqaiq area of a pilot water-injection program.

One month's seismic work was done offshore, covering about the same area as studied in 1949-51, but employing improved techniques to clear up previously undetermined results.

Exploration in Turkey has only recently gotten underway with final approval of concession applications. The approvals were of 171 separate and conflicting applications to be reduced to a lesser number of licenses covering 82 areas with a maximum of 125,000 acres each. Applications were judged according to exploration already done by the applicant and on exploration to be done in the future.

Among the 12 companies which received concessions are: American Overseas, N.V. de Bataafsche Petroleum Maatschappij (Shell Group), Bolsa Chica Oil Corp., Deilmann Montan G.m.b.H., Esso Standard (Turkey) Inc., D. D. Feldman Oil and Gas, Gilliland Oil Corp., Husky Oil Corp., Istanbul Natural Gas Co. and Turkiye Petrolleri Anonim Ortakligi, owned 51% by the Turkish Government. It operates the Ramandag and Garzan fields of southeastern Turkey.

An exploration concession was granted in November 1955 in Yemen to Yemen Development Corp., a U.S. group headed by George Allen. The concession covers 40,000 square miles in the northern two-thirds of the country and has a 30-year duration, although if discovery of oil or minerals is not made in six years the contract is void. Surface exploration began in January. The concession does not conflict with that of Deilmann Bergbau which occupies the whole coast area of the country (not including offshore rights) to the tops of the first mountains and is bounded north and south by the boundaries of Yemen.

Other Eastern Hemisphere

Europe—Exploration in Europe was dominated by the new discoveries in Italy, the development of the Parentis discovery in France, the release of Austrian oil from Russian control and the steady growth of German production.

In Italy the uncertain status of the proposed petroleum law retarded exploration. Petrosud Company, owned equally by Gulf and Montecatini Companies, has shut in its 2,000 b/d January 1954 discovery of Cigno No. 1 near Alano on the Adriatic coast, pending receipt of an exploitation right which is in turn probably dependent on the passage of the proposed law. A second well, Cigno No. 2, reportedly hit oil at 2,604 feet in early 1955 and on being deepened found another pay at 7,544 feet in September 1955.

Meanwhile Somicem, an affiliate of the government's Ente Nazionale Idrocarburi (ENI), reportedly found oil at 1,640 feet near Vallecupa, only about two miles from Petrosud's well. It is probably in an extension of the Cigno No. 1 field. The same company reported a discovery in September at 9,840 feet some 62 miles south of Allano near Cerni, known as the Casal Bordino well. A third discovery by the same company was reported in November 1955 near the Vallecupa discovery, known as the Madonna della Croce well, about 200 yards west of Petrosud's concession.

Meanwhile, ENI and its affiliates have continued exploration with a heavy rig set up seven miles from Ferrara during late

(Continued on page 108)

A modern refraction seismograph system.

The search for oil in unexplored areas throughout the world has revived demand for a primary reconnaissance method discarded by the industry nearly a quarter of a century ago.

REFRACTION REVIVAL

By R. W. Olson

Robert W. Olson, president of Houston Technical Laboratories, has a solid background of experience in electrical and electronic engineering. He joined Magnolia Petroleum Co. in 1938, working for a short time in the field with a seismograph crew and then transferring to the laboratory. From 1940 to 1945 he was with the Naval Ordnance Lab and the Navy's Bureau of Aeronautics. In 1945 he joined Geophysical Service, Inc., as chief engineer, later became vice president for research and engineering of Texas Instruments Inc. During this period he also advised on the formation of a medical electronic lab at Southwest Medical School of the University of Texas in Dallas. Since 1953 he has been president of HTL in Houston engaged in geophysical instrumentation. Author of technical articles and holder of a number of patents in geophysics and other fields, he is active in the affairs of the Institute of Radio Engineers, the Society of Exploration Geophysicists and is a member of various other technical and professional organizations.

IMPROVING world economic conditions in 1951, 1952 and 1953 suggested an increase in the exploration of high potential and virtually virgin, but long dormant foreign oil provinces. Most of these areas are, from the standpoint of petroleum exploration, quite primitive. A hasty review suggested that the first geophysical method offering detail which might be used in these primitive areas might be the refraction seismic method.

Instrumentation and techniques have improved but, basically, the exploration situation in many primitive areas is probably much the same as it was on the Texas Gulf Coast in the twenties; i.e., an educated hunch, surface geology, a reconnaissance survey by gravity or some other classic reconnaissance method. Then a "thin" seismic program (probably refraction) to find the larger features, followed by conventional reflection shooting for details, and later by even more detailed methods.

This belief is supported by considering:

(1) the history of several oil provinces in various stages of development.

(2) the relative success of reconnaissance methods in foreign (and usually primitive) petroleum areas.

(3) attitudes of prominent geophysicists and geologists whose problems are principally in areas in a primitive state of development of petroleum resources. This last point was discussed recently (Dr. Germain-Jones, EAEG Presidential Address, 1954.)

When the demand arose for a set of refraction equipment (equaling the specifications of an excellent early design by Carter Oil Company) for use in a foreign primitive area, one could conclude that the start of a considerable demand for modern refraction equipment might be here.

This was the incentive. The task was accomplished by studying Carter's early design, setting specifications to equal it, and then applying recent techniques and substituting improved components to replace the-by-now obsolete components used in the twenties and early thirties. New low noise tubes and better resistors and condensers together with techniques coming into use in the interim should render the job a little easier than when earlier refraction systems were designed.

The result—an updated refraction system is shown in Figure 1.

It has most or all of the old-fashioned virtues of classic refraction lore:

(1) extremely low frequency response.

(a) seismometer, natural undamped frequency 2 cycles, damped 0.6.

(b) amplifier flat above 1 cps; down 3 db at 1 cps.

(2) wind noise filters—8, 12, 16, 24, 32, 48 cps.

(3) sensitivity high—displays background under all circumstances. 5V/in/sec. No preamp required.

(4) plus a modern improvement—hum bucking seismometers.

It is conceivable, since the refraction method has been largely passé for 20 to 25 years, that many readers do not clearly distinguish it from the relatively well known reflection method.

As implied by the name of the method, interpretation of reflection seismograph results is based on measurement of time required for the energy of a wave to be transmitted to a *reflecting boundary and be reflected and transmitted back;* whereas in the refraction method, data is interpreted by means of measurement of the time required for the energy of a wave to be transmitted

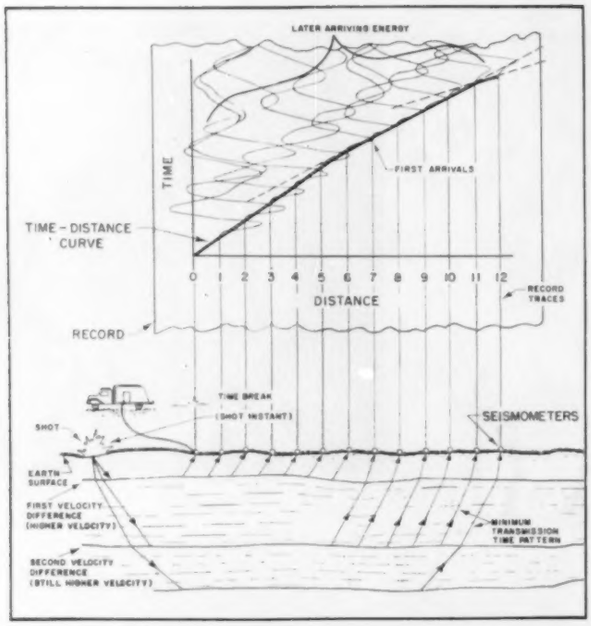


FIG. 3
Schematic representation of refraction method of seismic prospecting, showing shot, seismometer (or detector) ground plan, the record and time distance curve.

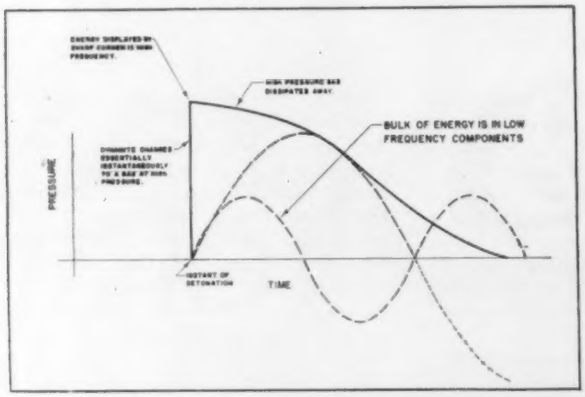


FIG. 4
Graphic representation of output of dynamite explosion.

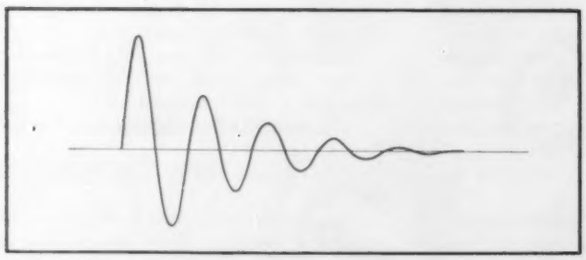


FIG. 5
A damped wave train received from a shock excitation such as shown in Figure 4 after transmission through elastic media such as the earth.

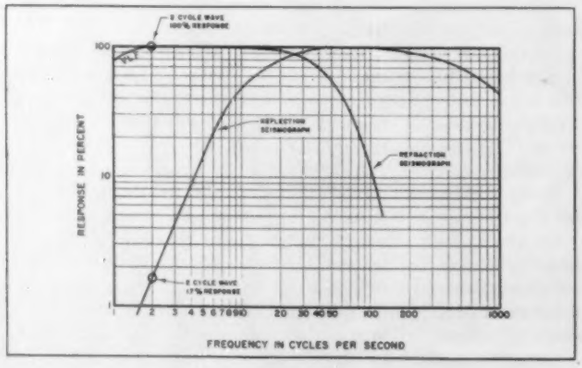


FIG. 6
Comparison of response of a specialized refraction and a high quality reflection seismograph.

(and in the process refracted) ***through*** the unknown body.

In crudest analog, reflection seismographing may be likened to echo ranging, while the refraction method is a little more closely related to measurement of distance by timing the direct (by the shortest path) transmission of sound.

In the simplest application of the refraction method of seismic prospecting for oil, a disturbance is initiated in the earth by detonating a charge of dynamite. The resulting elastic waves (sound) are detected at a number of points spaced away from the shot in a line on the surface of the earth. As a result it is possible to plot a time (of first arrival of elastic waves) versus distance (from shot to point of detection) curve.

Figure 2 is an actual refraction record. First arrivals are indicated by the first significant movement of each trace.

Figure 3 is a highly schematized illustration showing at the bottom a section through the earth and the ground plan of a refraction setup, and at the top a piece of refraction record, with a time distance curve superimposed. Note that the elastic waves travel near the surface to detectors 1-6, but that the fastest path (and consequently the first arrival) to detectors 7-11 is through the earth into the second (high velocity) layer, and that first arrival to detector 12 is through a third of still higher velocity layer. No detailed explanation will be given in this short article beyond saying that a fairly accurate determination of the depth of each of these layers is possible.

A discussion of the mechanics of generating and transmitting elastic waves is necessary to an understanding of the method and particularly to an understanding of instrument requirements.

Dynamite detonates so rapidly that it is for most purposes satisfactory to assume that the solid dynamite changes instantaneously to a gas body at very high pressure, having the same shape as the dynamite. The high pressure makes its force felt against the walls of the cavity in which it is detonated as an intense push in all directions after which, depending on other conditions, it dissipates its energy in any of several characteristic ways. The simplest manner is merely blowing water, mud, rocks and any other impediments out of the hole. The pressure applied to the earth might look like Figure 4.

The wave shape in Figure 4 may be thought of as being made up of all frequencies from very low to very high frequencies. The energy of its high frequencies is known to be responsible for the sharp angular "leading edge." The bulk of the energy, however, is represented by the area inside the single half cycle of the low frequency wave and its second harmonic, with higher harmonics showing less and less energy.

It is well established that viscous resistance (friction), such as the earth offers to the passage of elastic (mechanical) waves, dissipates the energy of high frequencies more rapidly than low frequency energy

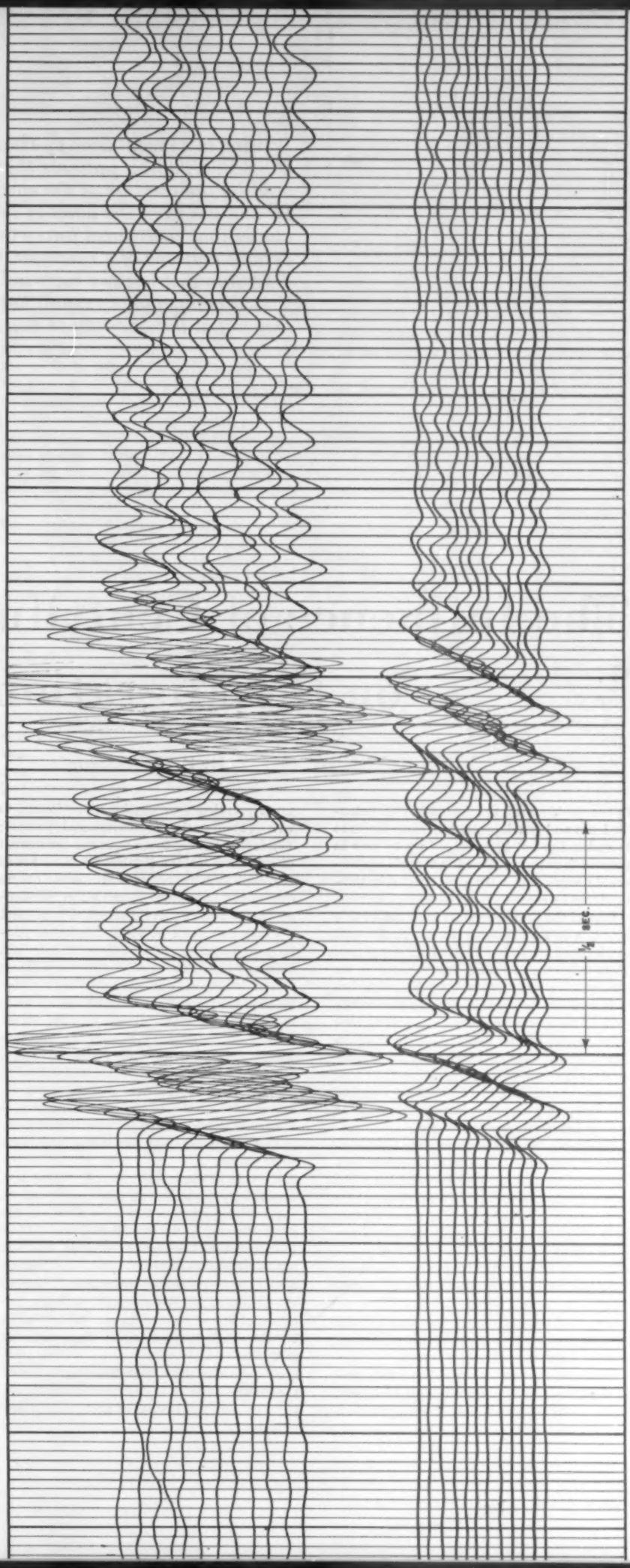


FIG. 2

This refraction seismograph was recorded with a VLF system near Houston. The record was made at a shot-to-detector distance of five miles with a five-pound charge. Seismometers were placed 100 feet apart and a frequency pass band extending from 2 to 24 cycles per second was used.

(waves) and that a transmission mechanism will oscillate when shocked. Thus the pressure pulse starting out as an almost square wave will, after extended transmission through the earth, look like a damped (decaying) wave train having predominating low frequencies somewhat as shown in Figure 5.

Figure 6 is a response (or efficiency of response) curve for two seismic systems; a good refraction system having 2-cycle seismometers and 1-cycle amplifiers, and a typical good reflection seismic system having good low frequency response. A 2-cycle wave applied to the refraction system would result in a response-deflection on the record about 55 times that shown by the reflection system. In order for the less efficient (at low frequency) reflection system to give an equivalent response, 55 times the amplitude would be necessary and this might require several thousand times as much dynamite. It should be pointed out that the occurrence of 2-cycle energy is a rather extreme situation, representing conditions likely to be met in extremely long shots where the objective is very deep data. Three and four cycle energy is observed frequently if the equipment is capable of responding effectively.

Note that if a system is incapable of responding to low frequencies, higher frequencies will be displayed. These, however, are much more severely attenuated and will require disproportionately large charges to be transmitted long distances.

Maximum utilization of the advantages of the refraction method (for deep data) requires very long shots causing very low frequencies to predominate, and obtaining the *most extended low frequency response possible*. Obviously, short (and shallow) refraction work can be done with reflection equipment, but for really long shots and the resultant deep data, it is necessary to use specialized equipment capable of very good, very low frequency response.

An appropriate concluding consideration is—what will refraction do to find oil?

(1) It will "work" in some areas where nothing else will.

(2) It is a very useful technique in primitive areas—frequently giving all the information necessary for early exploitation from a very thin geophysical program.

(3) It sometimes gives added information or confirms other information.

(4) It determines velocities for later reflection programs.

(5) Specifically, it is capable of at least:

(a) Locating and mapping salt domes.

(b) Determining dips.

(c) Determining depths to dominant beds.

(d) Locating significant faults.

Writing in a recent issue of The Petroleum Industry *published in the U.S.S.R. Viktorov presents the theory that centrifugal force generated by the rotation of the earth is instrumental in the migration of oil and gas from the point of origin to today's traps. The author concludes that centrifugal forces will tend to concentrate oil deposits in certain portions of a reservoir. Conditions found in the Grozny and Dagestan districts are reported to conform to the theory presented. The accompanying translation omits the author's mathematics in arriving at the quantity of petroleum displaced per thousand years.*

The Influence of Centrifugal Force on the Migration of Petroleum

By B. N. Viktorov

The problem of the formation of petroleum and gas deposits has many facets to it and it has not been solved up to now in respect to many points even though considerable work has been devoted to it, particularly in recent years.

One of the basic elements involved in this problem is that relating to the modes and the laws of migration of petroleum and gas. That migration as such takes place is an indisputable assumption. Only by migration is it possible to explain the regular existence of petroleum and gas in anticlinal elevated parts of the monoclinal fold or in zones of explosions. Petroleum, in obedience to the law of gravity, is found in low synclinal parts only in conjunction with insufficient quantity or complete absence of porous layers containing water.

Moreover, various authors state the character of migration itself in divers manners. The majority of investigators hold the view that the formation of petroleum takes place in what are called mother clay rocks (silts), from which it is subsequently extracted together with water under the action of pressure. It is only after becoming displaced from the point of formation that oil accumulates in certain places.

The gravitational theory accounts for the formation of large accumulations of petroleum and gas in a simple manner.

Views held at the present time with regard to the process of formation of layers converge upon the action that is exerted upon petroleum or gas by three forces, to wit: (1) flotation (gravitational forces); (2) forces having to do with the movement of stratified waters (hydraulic forces) and (3) capillary forces, with still some others dependent in various instances preponderantly upon the concrete physical condition.

From our point of view the forces participating in the matter of formation are not exhausted with the present summary. These forces must, in our opinion, be supplemented by forces that have to do with the rotation of the earth around its axis, i.e. by centrifugal force and Coriolis. The absolute magnitudes of these forces are not large, but if we consider their incessant action in geological measurements of time going on moreover in one and the same direction, it is easy to assume (and to expect) that very palpable results may be connected with their action.

By way of example respecting the action exerted by these forces one may point to the washing away of the right banks of the rivers flowing in the meridianal direction of the northern hemisphere and of the left banks of the southern hempishere (law of Baer), in consequence more specifically of the action of forces connected with the rotation of the earth and known as the forces of Coriolis, exerted upon the aqueous medium.

Calculations show that the magnitude of the forces of Coriolis is extremely small, but as is known, the results of their action are very palpable. On the other hand, the magnitude of the centrifugal forces is several score times greater than the magnitude of the forces of Coriolis and consequently the results of their action must be still greater.

As is known, connected with the forces of Coriolis are also such phenomena of the bending of the paths of the sea current, the declination of the wind from the direction of the gradient of pressure, the declination of falling bodies thrown and freely fluctuating (Phuco pendulum, flight of projectiles), etc. The shape of the earth itself is connected with the action of centrifugal force, having as it has a slight flattening at the poles, constituting 1/298, and there is no gainsaying that this force also acts upon any liquid and gaseous medium, calling forth in any event the movement thereof in the direction of the axis of rotation.

The whole thing lies in this, that one of the phenomena connected with the action of small forces (steepness of the banks of rivers, declination of the pendulum, etc.) is observed by us direct and therefore it is accepted as something absolutely obvious, whereas phenomena that are connected with the action of these forces, but are hidden from direct observation escape our attention and therefore are not always considered by us.

If these forces act upon water and gas situated on the surfaces of the earth (declination of currents, declination of the wind), then from our point of view they also un-

qualifiedly act upon liquid and gas found in the bowels of the earth.

The known and, perhaps, sharp difference in the absolute magnitudes of these forces will flow from the conditions of situation of liquids and gas in the first and second instances, so far as in the first they are found in a free state while in the second they are subject to the expanse of rocks containing them, but from the angle of fundamentals the difference in these conditions is of no importance.

The author has conducted detailed calculations of these forces and the results of the action of these forces on petroleum and gas that are at work in the conditions of the layer. In connection with this the author, considering the physical condition of hydrocarbons in the earth (liquid, gaseous) and their densities, assumes in the first place that all the laws of filtration apply to them and that the action of gravitational forces (forces of flotation) is operative if not in all cases then at least in many when the collectors containing petroleum and gas are sufficiently permeable.

The calculations conducted indicate that the forces of Coriolis acting under the conditions obtaining in the earth are very small in their absolute magnitude and that an immeasurably great interval of time is essential to make their action noticeable in the direction of the migrating currents of petroleum and gas. On the other hand, the magnitude of the centrifugal force acting upon petroleum and gas is large and cannot help but make itself felt in some instances by increasing the effect of migration and in other instances by reducing it.

The following is the basis of the present article: the action of basic forces causing the migration, that is to say of the forces of flotation outside of dependence upon other factors, is at all times directed towards the roof of the anticline according to the elevation of the layers; i.e., connected directly with the fold, is always at work at the same time as the centrifugal force in the same direction independently of structural conditions, but specifically in the direction from the axis of rotation. Consequently, for the fold located in the northern hemisphere and latitudinally oriented, the migration of petroleum and gas to its roof under the conditions obtaining in the northern wing will take place under the summary action of forces of flotation and the centrifugal force, but under the conditions obtaining in the southern wing under the action of a force representing the difference in the action of these forces so far as the direction of their action is diametrically opposite (Fig. 1).

As a result of such reciprocal action of the forces the accumulation of petroleum or gas, other conditions being equal, will be greater in the northern wing than in the southern wing, that is to say the contour of the content of petroleum of the northern wing of the fold will be wider than it is on the southern wing, and the gypsometry of the contour of the northern wing will be lower than that of the southern wing.

However, such a phenomenon perforce will be observed not for all of the latitudinally oriented folds without exception, but only for those with a sufficiently large inclination of the wings. On the other hand, for the folds with angles of inclination of the southern wings proportionate to or smaller than "the angle of equilibrium" (see Fig. 2), the picture of the situation of the contour will be the opposite, for the reason that in this case at the expense of the preponderance of the centrifugal force over the forces of flotation the movement of the petroleum will take place from the roof of the southern wing. Furthermore the discounting of centrifugal forces permits of the determination of the above-mentioned "angle of equilibrium," i.e., the angle of the inclination of the layer, in the presence of which there will be no movement of petroleum to the roof of the fold even should the layer have a structure over and above the capillary structure and even should its permeability be ideal.

To this it is necessary to add that the concept "angle of Equilibrium" is applicable only to the conditions obtaining in the southern wings of the folds, i.e., to conditions under which the petroleum under the action of forces of flotation has to move from the south to the north; this concept is not applicable to the conditions that obtain in the northern wings, for the reason that in this case (in view of the elevation of the layer towards the south) the petroleum even in the presence of insignificantly small angles of inclination that adhere up to the horizontal position and even adherence to the opposite inclination, though at an angle less than the "angle or equilibrium," will nevertheless move in the direction from north to south under the action of the centrifugal force only.

It should be noted that there must also be linked with this condition the phenomenon that even in the case of an ideally symmetric tectonic structure of the synclinal regions (the petroleum collection area) surrounding the anticlinal and feeding region of the northern wing of the anticlinal will be greater than that of the southern wing (Fig. 2).

Starting out from the premise that under the conditions obtaining in the southern wings of the latitudinally oriented folds of the northern hemisphere the basic force counteracting the movement along the wing of the roof of the fold is the centrifugal force (forces of adhesion and others will counteract the one and the other in the same measure), we have found that the "angle of equilibrium" for petroleum, being equal to 0 under the conditions obtaining at the pole and the equator, will reach maximum at latitude 45° and constitutes 24′. The value of this angle will also vary in a way dependent upon the specific gravities of petroleum and the layer water. Analogous calculations have also been made for gas.

It must be added to what has been stated that naturally enough not only petroleum and gases but also the water contained in the same layer will be subject to the action of the centrifugal force, a given circumstance that will strengthen the phenomenon noted by us, by favoring the movement of petroleum or gas to the roof of the fold under the conditions obtaining at the northern wings, and, on the other hand, hampering it under the conditions obtaining in the southern wing.

Of course, the theoretical postulates laid down here do not exhaust the facets of the problem of formation of petroleum and gas deposits and can be considered merely to be an individual link in the complicated chain of this process.

Without deciding beforehand on the final resolution of the question dealt with, its importance in the matter of learning the laws that govern the paths and the conditions of migration of petroleum and the formation of petroleum deposits, we contend that such an approach towards the solution of the problem permits considerable light to be thrown upon a number of knotty questions relating to the formation of petroleum and gas deposits.

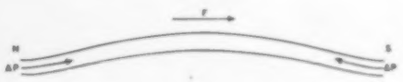


FIG. 1

Diagram indicating direction and types of forces influencing oil accumulation.

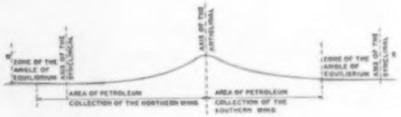
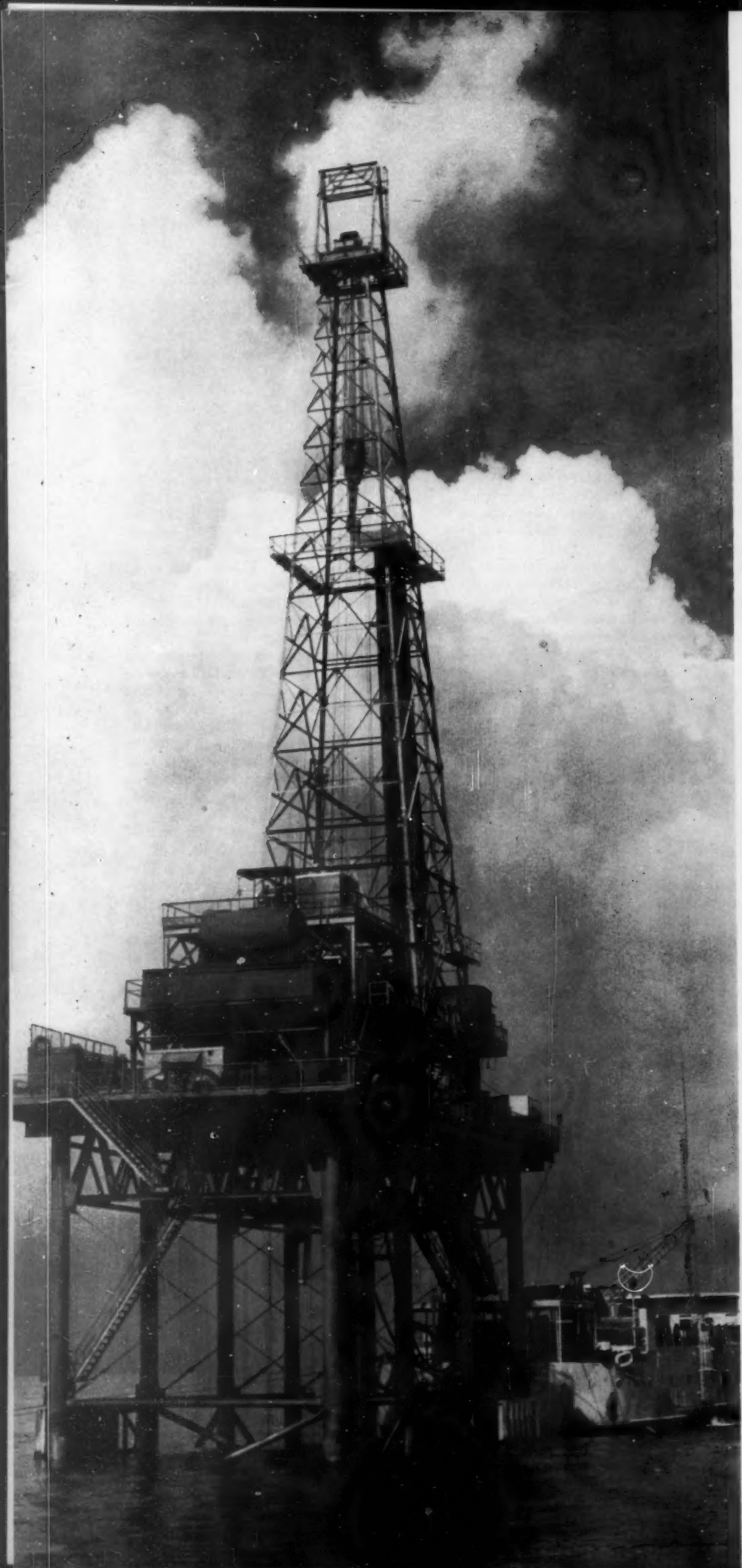


FIG. 2

Diagram showing areas of oil accumulation in northern and southern wings.



Seagoing

STRANGE skyscrapers rising above the waters of the Gulf of Mexico, far from the sight of land, have become the trademark of Gulf Coast oil men.

These are the platforms, the submersible barges, the mobile units and the huge self-contained, man-made islands of steel from which the work of drilling for oil and gas in the submerged tidelands of Texas and Louisiana has become one of the South's biggest industries.

By latest count there are in operation or various stages of construction 22 mobile rigs, 40 drilling tenders, and 20 or more self-contained platforms, with hundreds of tugs, barges, supply vessels, crew boats, plying the waters of the gulf to deliver men, supplies and materials to the offshore oil prospectors; and onshore, in a score or more of shipyards and fabricating plants, new tools of the trade are being turned out as rapidly as "round the clock" shifts can build them.

The building boom is just now going into high gear. Many oil men believe it is good for another year or two. One drilling company official, asked when he thought the saturation point would be reached, remarked:

"I don't know, but if we had a dozen mobile rigs right now we could find work for them."

Conservative estimates place the building peak at this year's end, with a gradual tapering off to follow until the offshore industry has enough tools and equipment to properly develop state and federal leases as near the edge of the continental shelf as business economics will permit. But today the fabricators are fighting for steel and

The drilling tender Ernie Miller, *one of four such vessels owned by the CATC group, lies at anchor bow to a permanent drilling platform in the West Delta field near the mouth of the Mississippi River. This method is most often used in the offshore oil and gas fields. The tender, a non-self-propelled vessel, provides power for mud pumps, storage for pipe, cement, mud and other drilling materials, and quarters for the drilling crew.*

SKYSCRAPERS

Forty-five oil companies have spent a billion dollars for Gulf offshore leases and equipment. They are building a fleet of mobile barges to supplement fixed platforms in the big push to find submarine oil. Current output of offshore wells averages 62,000 barrels daily.

By James W. Calvert

the oil companies are clamoring for more and bigger equipment with which to penetrate the bowels of the earth in deeper and deeper water.

The newest mobile rigs to go into service are The Offshore Company's submersible barge No. 3, built at Alexander Shipyard in New Orleans, and Kerr-McGee's Rig 45, converted by Ingalls Shipbuilding Corp. of Pascagoula, Miss. from an inland waterway drilling barge into an offshore unit capable of operating in 35 feet of water.

The unit newly added to The Offshore Company's fleet, is a submersible drilling barge, 200 by 74 feet in size, which utilizes the famous DeLong jacks for stabilizing the structure on the ocean floor to prevent shifting. The barge is now drilling for Sun Oil Co. off the Louisiana coast near Morgan City.

The barge supports the drilling platform on 23 fixed tubular columns, 52 feet in length. Four spuds, or steel pilings, are driven into the ocean floor by means of the DeLong jacks to prevent sidewise movement due to sea action or scouring.

The unit is entirely self-contained, in that it provides quarters for the drilling crew, storage facilities for pipe, mud, cement, fuel and other supplies, and power to drive the rig and mud pumps. The platform consists of a cellar deck drill floor with a heliport on the roof of the air conditioned living quarters.

Drilling equipment includes a National Supply Ideal 130E drawworks with auxiliary brake, catheads and core reel with drive. Elliott Electric generators drive the drawworks and rotary. Main power of the rig is a three-engine compound consisting of Superior model PTDS-8 diesel engines having a power rating of 2,010 hp. The compound powers two Emsco D-850 mud pumps through Ideal Gyrol fluid drives. Two Caterpillar D-397 diesel generators provide auxiliary power and sea water is distilled by two Mechanical Equipment Co. 600 gph distillation units.

The drilling slot is 25 feet 11 inches wide and 36 feet two inches long. The rig is equipped with a 140-foot Lee C. Moore derrick with a drilling capacity of 16,000 feet. Other equipment includes a Rhumba double shale shaker, a Halliburton cementing unit, Lightning mud mixers and a Schlumberger unit.

Two ocean drilling giants get a refurbishing at Alexander Shipyard in New Orleans. In the foreground is American Tidelands' barge "101," repaired after capsizing in the Gulf of Mexico last summer. The barge at right is Offshore Company's No. 3. Shortly after this picture was taken, the drilling barges were completed and towed to sea. They are now working in the submerged oil fields offshore from the Louisiana coast.

In height the rig is 64 feet from the bottom of the barge to the floor of the drilling platform.

In operation, the barge is submerged one end at a time until it rests upon the floor of the ocean. Then the DeLong jacks are activated to drive the four steel spuds into the ocean floor to a depth of about 35 feet. The spuds provide no support for the structure other than to maintain its rigidity.

The Offshore Co., one of the leaders in the offshore drilling field, now has two additional mobile platforms under construction at the U.S. Steel plant in Beaumont, Texas. They are similar in design to Offshore No. 1 and No. 2 in that they are mobile structures wholly supported by steel piles.

The platform consists of a single barge upon which is mounted the self-contained drilling unit characteristic of all deep water structures. The barge is towed to the drilling location whereupon the steel piles are driven into the ocean floor by means of DeLong jacks. When a firm foundation has been established, the platform literally climbs the piling, the jacks operating in much the same manner as a small boy "shinnying" up a tree. When the desired height is reached the platform is locked into place.

DeLong Construction Co. of New York developed these unique jacks during World War II and used them to build docks in remote island locations. Later they were adapted for use on the offshore drilling platforms by The Offshore Co., which is

owned by the DeLong Construction Co., J. Ray McDermott Co. and Southern Production Co.

The new Offshore Co. platforms, designated as No. 4 and No. 5, will be slightly smaller than the two platforms now in operation. They will be 200 feet long and 104 feet wide and will be supported by eight legs. By contrast, Offshore platform No. 1 has 12 legs and No. 2 has 14.

The new Kerr-McGee Rig 45, a modification of Rig 44 (described in WORLD PETROLEUM, November, 1954), was converted from a shallow water unit and is now drilling for The Texas Co. in the Eugene Island area off the Louisiana coast.

The conversion consisted of salvaging the superstructure and drilling machinery from Rig 35, building a new hull 142 by 69 feet, a new superstructure deck and submersible pontoons. New equipment also includes additional pumps for potable and drilling water and diesel fuel, air conditioning and heating units.

Kerr-McGee has another mobile unit under construction at the Ingalls yard and a new drilling tender now being built by Equitable Equipment Co. at its Madisonville, La. shipyard.

Alabama Dry Dock and Shipbuilding Co. of Mobile has promised completion by midsummer of Coral Drilling Company's new submersible barge which can operate in 67 feet of water. This structure, designed by Friede & Goldman of New Orleans, is similar to the California Co. barge built at the same shipyard two years ago, but will have a bow section shaped to facilitate towing.

The structure is 180 feet long, 151 feet wide and will draw 6 feet 3 inches under tow. The lowest deck will be 82 feet above the hull. Most of the machinery will be located in the lower hull, which also will provide stowage for fuel, water, mud and cement.

Drilling equipment will include Brewster N-12 drawworks and two 1,000 hp pumps. The mud pumps, drawworks and rotary will be driven by diesel electric power. The Coral Co. rig will be christened "Mr. Arthur."

Barges of similar design are now being built by Avondale Marine Ways, Inc., New Orleans, for Delta Offshore Drilling Co. and Southeastern Drilling Co. These two rigs, 156 by 90 feet in size, will be capable of drilling in 25 feet of water.

Still another platform now under construction is being built for Penrod Drilling Co. by Bethlehem Steel Co. in its Beaumont shipyard. This structure, designed for drilling in water up to 70 feet deep, will be similar to C. G. Glasscock Drilling Company's "Mr. Gus," built in the Bethlehem yard more than a year ago.

Fundamentally offshore drilling structures fall into three categories: the mobile unit which is floated to a location and then submerged or drawn up on piling to form a fixed structure; the small permanent platform served by a floating tender; and the large self-contained platform. However, Magnolia Petroleum Co. recently announced plans for a method which utilizes all three techniques.

The Magnolia system is to drive piling to a depth of eight feet below the surface of the water to form a nest upon which a shallow water drilling barge will rest. If a well is completed the pilings will be extended above the surface for a production platform; if the well is dry the barge will be refloated and the underwater structure removed.

Magnolia calls its system the "bird-on-a-nest" method and will use it first on a location near the mouth of the Mississippi River.

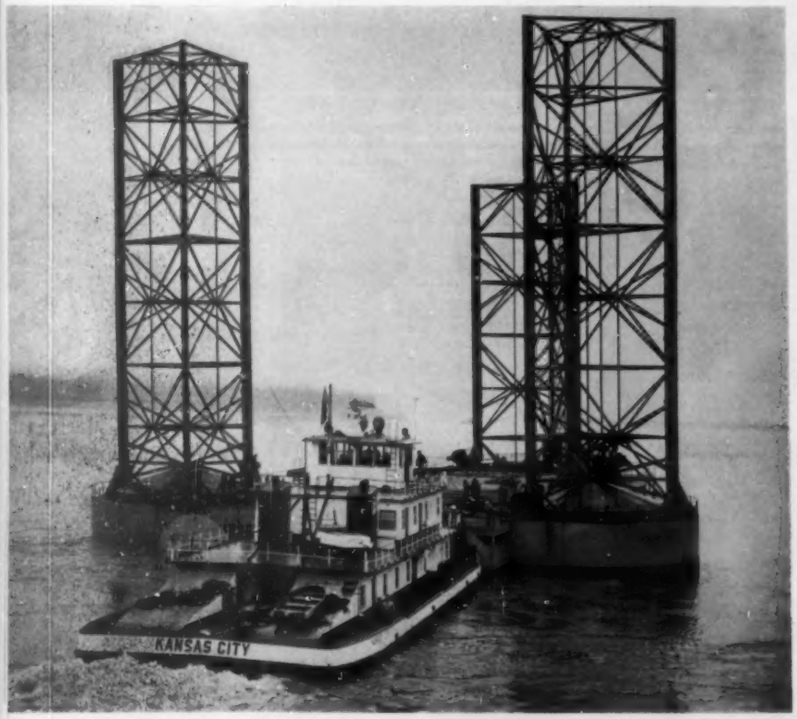
Two of the biggest problems of offshore prospectors are transportation and housing, and the further away from shore oil men go, the more acute these problems become. Wells 50 miles or more at sea require servicing by seagoing vessels and the naval architects are faced with the problem of creating crew and supply boats which combine relatively good speed with the ability to withstand heavy seas.

There has been little standardization. Equitable Equipment Co., for example, has built heavy duty supply boats for three companies and each vessel has been constructed from a different set of plans. One vessel has the pilot house aft and has a divided deck to provide a driveway for loading trucks; another has the pilot house far forward and resembles a miniature version of a Great Lakes ore boat; a third follows more conventional lines, having the appearance of a small freighter.

Equitable vice president, Marlin G. Lugwig, explained that the design of hulls for offshore supply boats is the outgrowth of the LCT-type of World War II, so admirably suited to the purpose because of their relatively shallow draft. As drilling moved greater distances offshore, there arose a need for supply vessels with a cargo capacity of 100 tons or more. The self-propelled barges, useful for transporting supplies to marshland drilling rigs, were wholly inadequate for offshore work.

Halliburton Oil Well Cementing Co. first developed a self-propelled vessel named the "Tiger Class," 124½ by 31½ by 9¼ feet, having an assigned ABS loadline for a cargo capacity of about 400 tons. While Halliburton vessels are equipped with special cementing equipment, the same design is used for supply vessels to transport such heavy cargoes as pipe, cement and drilling equipment. The vessel also has tanks for the transportation of drilling water to the offshore rigs.

The "Tiger Class" boat, resembling a small ocean freighter with superstructure aft, has been adapted to the needs of the Louisiana Shelf Marine, Inc. It is powered by two GM model 12007 diesel engines with 4:1 reduction gear. Generators are two GM diesel powered 40 kw sets, model ACK-40; generator is a Delco model YI-499.



The LeTourneau self-elevating drilling island being moved down the Mississippi River from Vicksburg, Miss., en route to Galveston, Texas, for equipment with the drilling rig. The platform has a deck area of more than half an acre, weighs more than 4,000 tons and rides up and down three 140-foot stilts. Zapata Off-Shore Co. of Houston will put the rig into service during the coming summer.

Equipment includes a Markey type WEWB-10 anchor windlass with a five hp waterproof marine motor; two 300-pound Danforth anchors; Markey vertical capstan stern warping winch with 10 hp motor; Vickers hydraulic steering gear; two Gardner-Denver model S-121-M air compressors; Fairbanks-Morse ballast pumps with power takeoff from main engines; Deming bilge pumps; Carver fire and bilge pump; Gardner-Denver type B main fuel oil transfer pump; Allen Bradley marine type electric starters; Hotstream electric water heater; Hotpoint electric range and refrigerators; Decatur Pump Co. pressure sets; Carlisle and Finch searchlight; Hose-McCann pilot house telephones; Kearfott windows and Rostand airports.

A second type of twin screw supply vessel is the "M/V Tioga," built by Equitable for the California Co. This 131-foot boat, with pilot house and superstructure far forward to provide clear view ahead, has a beam of 32 feet and draft of six feet. It has passenger accommodations for 40 men and living quarters for a crew of eight.

The "Tioga" is powered with two 450 hp Caterpillar diesel engines, swinging two four-blade Columbia propellers. Auxiliary engine generators are two GM Delco 30 kw sets. Gardner-Denver centrifugal pumps provide ballast and fuel oil transfer. There is a Deming self-priming centrifugal fire and bilge pump, a Burks potable water pump and sanitary pump, and a Fairbanks-Morse centrifugal pump for lubricating stern tube bearings.

Passenger and living quarters are air conditioned by a Westinghouse 3-ton unit with air cooled condenser. The vessel was designed to operate from a shallow water base to rigs far offshore and to have the maximum maneuverability for handling in close quarters and around rig structures.

The third type cargo vessel, the "R. B. Kelly," was built by Equitable for Pure Oil Co., from the design of Christenson & Graham, Inc., of Pasadena, Texas. The "Kelly," 130 feet long with a 35-foot beam, has a cargo capacity of 3,600 barrels of liquids plus a deck cargo of 69 tons.

There is a large open well deck which can carry 10,000 feet of casing and the deck is heavily reinforced to carry a 65-ton crawler crane which can be loaded over the stern. To make this provision the superstructure is split, with the wheel house on the after starboard side and quarters on the port side.

The vessel is powered by two 450 hp opposed piston Fairbanks-Morse diesel engines. Twin rudders are powered by a Sperry-Gyroscope hydraulic steering system.

These three vessels, all intended for virtually the same type of offshore work, are under the 300 gross ton limitation of the U.S. Coast Guard.

A lighter vessel also intended for offshore work is a new 65-foot combination crew and light cargo twin screw boat designed by Oliver Bryant of Bayou LaBatre, Ala. With a rated speed of about 15 knots, the Bryant boat is primarily designed for transporting crews to and from offshore rigs and can operate far at sea. First of the Bryant boats will be powered with GM model 6-110 diesel engines.

Several new non-self-propelled drilling tenders are now under construction while the California Co. recently put another converted LST into the service of providing housing, power and storage facilities for permanent offshore drilling platforms.

The LST, rechristened S-25 of the California Oil Co. fleet, was converted by Avondale Marine Ways from designs of Friede & Goldman. Unlike most of the offshore tenders, the S-25 is self-propelled with the original main propulsion engines. Additional machinery includes power for mud pumps, mixing agitators, conveyor machinery and other specialized operations unique to drilling tenders.

Levingston Shipbuilding Co. of Orange, Texas now has under construction three 260-foot non-self-propelled tenders of the type built previously for the CATC fleet. One of the three is being constructed for the CATC group, a syndicate composed of Continental Oil Co., Atlantic Refining Co., Tide Water Associated Oil Co. and Cities Service Co.

Levingston previously had delivered four of these vessels to the CATC fleet and they have serviced scores of wells throughout the area. The tenders already in service are the "Jack Cleverley," "J. C. Craig," "Carle Sharp," and "Ernie Miller," all named for officials of the four major companies. The tender now being built for CATC has not yet been named, but is expected to be completed during the coming summer.

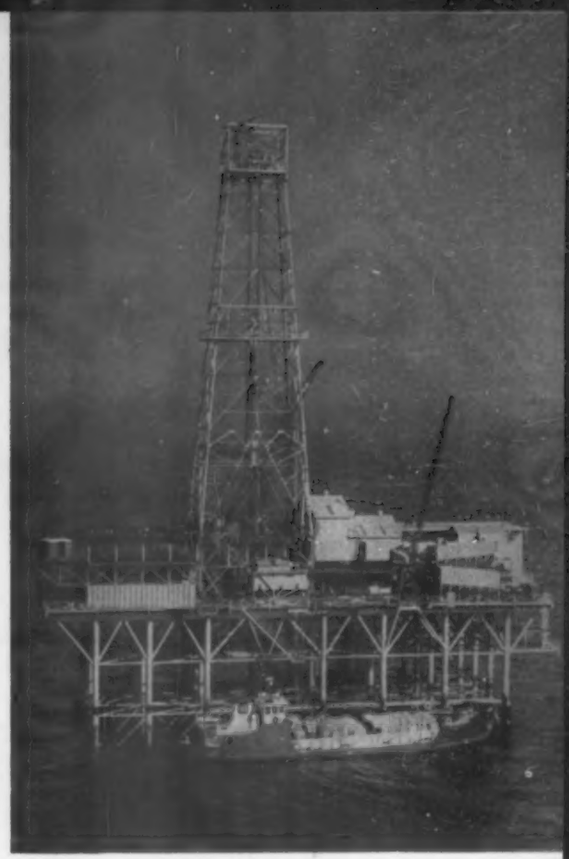
Levingston also is building tenders of this type for Llano Drilling Co., a subsidiary of Forrest Oil Co., and for Reading & Bates, Inc., drilling contractors of Tulsa.

In the construction of self-contained, multiple-well drilling platforms, Shell Oil Co. has announced plans for a six-well structure to be built in 60 feet of water in the Eugene Island area off the Louisiana Coast. Shell is to be the operator in a joint venture with Union Producing Co. and the first well is to be a north offset to wells drilled by the Magnolia group which has two proven wells in the area. To the south, Phillips Petroleum Co. has just built a permanent self-contained platform.

The new Shell platform is similar to the initial structure erected in 72 feet of water near the mouth of the Mississippi River. That structure is 197 feet long and 82 feet wide, and the distance from the bottom of the steel piles to the top of the derrick is 650 feet, about the height of a 50-story building.

Shell engineers decided a permanent type platform was the only practical means of drilling in the deep water and very soft, muddy sea bottom found in this area. Piling was driven 200 feet below the ocean floor before finding a solid foundation.

The main deck of the platform is 45 feet above the mean water level and the derrick towers another 160 feet.



Newest self-contained platform to be constructed in the Gulf of Mexico is this structure built by Shell Oil Co. in 48 feet of water, about 45 miles from land in Eugene Island area field offshore from the Louisiana coast. It is now drilling the first exploratory well. The derrick can drill six wells and then can be shifted along the deck to drill six more. The 20 steel pilings which support the 82 by 196-foot drilling deck penetrates the sea bottom to a depth of 140 feet. The platform is entirely self-contained, providing storage facilities for all pipe, mud, cement and other materials needed, as well as air-conditioned quarters for a drilling crew of 30 men.

Below the drilling deck and about 10 feet above the water is a short deck with two rows of holes through which wells are drilled. The crown block and rotary table can be shifted to a position over each of the openings. Six additional wells can be drilled from the platform by skidding the entire drilling unit some 22 feet along the platform.

Forty-five companies are now engaged in the offshore picture in the Gulf of Mexico. They have spent well over a billion dollars for leases, equipment and operating costs. The yield has reached a daily production of 62,000 barrels offshore from Louisiana alone, and is increasing steadily. The one-time landlubbers, who learned through trial and error the lessons of an unrelenting sea, are now seasoned seamen who can ride through a hurricane with the confidence of master mariners.

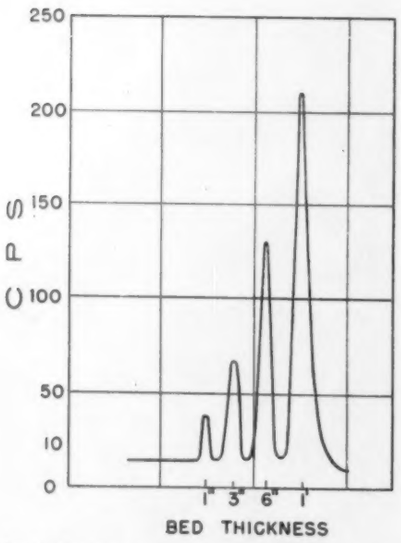


FIG. 1. *Response to different concentrations of ores of constant bed thickness.*

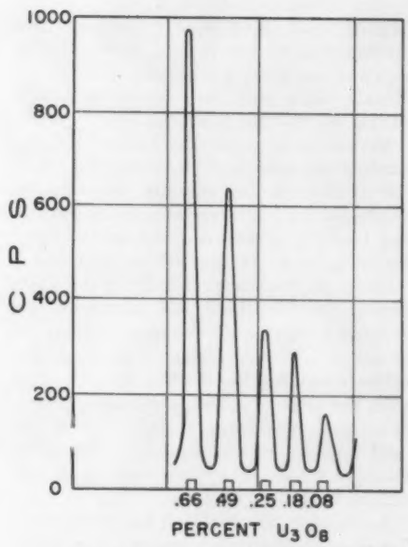


FIG. 2. *Response to beds of various thicknesses with identical concentration.*

The basic problems of the deposition of a mineral in a sedimentary section are common to the geology of both petroleum and uranium. The mechanics of fluid flows within the earth, depositional environments, and regional trends all are concepts which the petroleum industry has intimately studied for years in its search for new deposits. The common approach, vocabulary, thinking and philosophy allow an easy combination of techniques in the search for both

OIL AND URANIUM

By R. A. Broding[1] and Ben F. Rummerfield[1]

IT is becoming increasingly evident that the exploration for uranium ores is a science, just as is petroleum exploration. The merely random examination of outcrops of terrain does not begin to reveal the ore potentialities of an area. A systematic exploration program which is comprehensively directed and interpreted is essential to the discovery and development of radioactive ore bodies.

Recent uranium discoveries suggest that exploration for uranium should not be confined to a specific geological or geographical province any more than is exploration for petroleum. U_3O_8, like petroleum and gold, is where you find it.

A large area of common interest exists between exploration for uranium and for petroleum. It becomes apparent that the factors studied in either exploration effort can generally augment and facilitate the other. The radioactivity of sediments has long been recognized as a reliable parameter for geological studies. An interrelation of depositional, tectonic, and environmental conditions between radioactive minerals and petroleum constantly suggests that common relationships may exist also between the occurrence of these two groups of minerals.

The broad tectonic skeleton of both igneous sedimentary areas serves as a framework for the source, conduits, and reservoirs of mineral deposition. Studies concerning mineralization, lithology, and stratigraphy necessitate the use of such aids as structural contour, regional trend, isolith and isopachous maps. Regional dip, synclinal and anticlinal trends, possible channeling of old erosional surfaces, pinchouts, faulting and other common geological phenomena must be considered. The common approach, vocabulary, thinking, and philosophy allow an easy transition of thought from petroleum exploration to radioactive mineral exploration.

In many sedimentary areas such as the Colorado Plateau, it is feasible to combine petroleum and uranium exploration, with very little additional expense or effort. The equipping of field geological parties or geophysical crews with adequate gamma ray detecting instrumentation is easily accomplished. This allows the field parties to gather in addition radioactivity information which can be coordinated with the geological data normally obtained. The incorporation of aerial scintillometer surveys with airborne magnetometer surveys and the combination of other general reconnaissance investigations could prove ambidextrous in their application to both petroleum and radioactive mineral studies. The exploring for radioactive minerals has been discussed in various publications prepared by the Atomic Energy Commission and the U. S. Geological Survey. Many other excellent references by both private industry and governmental agencies are available.

When a combined effort is established to explore for both radioactive minerals and petroleum, it is sometimes difficult to determine a balance between the two. Uranium exploration, being the newer and the more "glamorous," has a strong appeal to the average geologist or geophysicist and care must be exercised that a proper perspective is maintained. For these reasons some of the major oil companies have found it expedient to set up their uranium exploration activities under a separate department which reports to the exploration manager.

An Advisory Committee on Radioactive Mineral Exploration under the leadership of Dr. Fred Lahee has been established by the petroleum industry. A report (which is partially outlined in the publication *Geophysics* for April, 1955) from this committee to the A.E.C. points out that to date 15 major and four minor oil companies have used A.E.C. probes in conjunction with their seismic programs. The A.E.C. also advises that in a two-year period its Grand Junction Operations Office has probed 2,352 shot holes for a total depth of 361,122 feet, through the courtesy of oil companies doing petroleum exploration in the Colorado Plateau area. Forty-three of these holes, or 2%, have been found to give anomalous radioactivity readings. This percentage figure may not be representative for all areas and would apply only to the Colorado Plateau area, which is one of the best-known areas in the U.S. for the production of uranium-bearing ores.

[1]*Century Geophysical Corp., Tulsa.* *This article is an abridgement of a paper contributed by the American Geological Institute for presentation at the Nuclear Engineering and Science Congress sponsored by Engineers Joint Council, Dec. 12-16, 1955 at Cleveland, Ohio. Publication here is through the courtesy of the American Geological Institute.*

Private exploration companies and consultants offer a logging and exploration service to the uranium industry. The U.S.G.S. and A.E.C. have parallel services which are utilized in their work and also in conjunction with the operation of the D.M.E.A. (Defense Minerals Exploration Act) of the Department of the Interior.

One application of petroleum exploration instrumentation and techniques to uranium exploration is the use of gamma ray and resistance logging. It is estimated that approximately three million feet of boreholes will be drilled this year in exploration for uranium on the Colorado Plateau alone. To evaluate this footage properly, it is necessary to obtain either continuous cores or radioactivity and resistance logs of the holes. As a matter of economics, it is not only a great deal faster to log the holes than to obtain cores, but it is also from three to ten times cheaper.

It is well known that a mantle of a relatively few inches will completely mask the effect of any underlying radioactive ore body; therefore, the drilling of test holes is essential to evaluate an area. The first reaction is usually to think in terms of utilizing a Geiger counter or scintillometer to investigate cuttings from the test holes. Since such an investigation merely indicates the possibility that an ore body has been penetrated, the next reaction is to suspend the probe in the borehole to determine the magnitude of the activity *in situ* and the depth of the source.

If the problem were merely to indicate the presence of an ore body directly as a "yes or no" proposition, it would be a relatively simple matter to solve it by these techniques alone. However, as familiarity with the field is acquired, it is realized that the determination of deposition and concentration of uranium ores is complex, and depends upon a relatively unknown interrelation of stratigraphy, lithology, and chemical conditions. Therefore, the "yes or no" type of exploration is completely inadequate. High calibre instrumentation is required that will yield a continuous log of the natural gamma ray activity as well as a log that will identify lithology. To meet this requirement, a combination gamma ray-electrical resistance log is considered to be the best tool known to date.

Since uranium itself is not a gamma emitter, it is important to note that the measurement of gamma rays cannot be used to detect uranium directly. Fortunately, the uranium series has five daughter elements that are gamma ray emitters. A gamma ray detector, therefore, measures the relative proportion of these gamma emitting elements in the ore, providing that it is in equilibrium. If the ore is in equilibrium, a calibration curve can be drawn which relates counts per second, or milliroentgens per hour, to percent U_3O_8 equivalent. Thus, a radiometric assay can be obtained in the borehole. Such surveys are correct only to within 15 to 20% but they are still helpful in providing a relative measurement of the ore concentration. Calibration curves must be established for each logging rate, time constant, bed thickness, borehole diameter, and the area involved. Chemical analyses should be run on cores obtained from "hot holes" to evaluate fully the properties of the cre body and, by comparison with the radiometric assay, to establish whether a condition of equilibrium exists. It has been found that conditions of inequilibrium, resulting in excessive radon gas or solution concentrations, can be detected by lack of reproducibility of anomalies in successive logs from the same hole. Experimental work is being carried on at present in an effort to solve this problem.

Figure 1 illustrates the response of a gamma ray detector in an artificial test hole to various concentrations of ores with constant bed thickness. A comparison log, shown in Figure 2, illustrates the response in an artificial test hole to ore beds of various thicknesses, but with identical concentrations. Calibration runs of this type are the basis for correction curves which are described later.

Experience has taught that uranium-bearing minerals have an affinity for sedimentary deposits where there is a change of facies. That is, lenticular fluvial sandstones that grade into siltstone and mudstone are more favorable for uranium mineralization than are massive clean sandstones. Carbonized fossil plant matter is usually associated with uranium minerals in sedimentary rocks; also, uranium minerals seem to prefer a buff or light-colored matrix in contrast to red-colored host rocks. Carbonates are usually low and phosphates are high in uranium content. Because of these factors, an accurate lithological log is an essential accessory to the gamma ray log. In some areas, the gamma ray log gives a fair indication of lithology. However, since this log measures only the amount of natural radioactivity in the rocks and does not necessarily indicate the type of rocks, the gamma ray log is considered to be a poor lithologic log. Resistance logging is recognized as the best means of obtaining lithologic information, since most rock types are characterized by definite ranges of electrical resistivity. The resistance log, recorded simultaneously with the gamma ray log, results in the ideal combination for uranium exploration.

Through the use of a combination resistance and gamma ray log, it is possible to construct regional "preference maps" outlining areas in which the uranium prospector is most likely to succeed. Regional dip, the pinching out, lensing of sediments, and other factors can be detected and used as sign posts in the effort to determine direction of mineralization.

Geological marker horizons often can be picked from the resistance logs and sometimes from the gamma ray logs. Shallow structural maps can be prepared which are valuable not only in petroleum exploration,

FIG. 3. *Typical logging operation on conjunction with seismic crew.*

but also in uranium exploration. In some instances formation identifications can be made. For example, in many areas of the Colorado Plateau the Salt Wash or Lower Morrison section can sometimes be identified by characteristic resistivity markers. This is significant, as the Salt Wash has proven to be the most important source to date of uranium ores in this area.

In many areas it is feasible to combine petroleum and uranium exploration, with very little additional expense or effort. The logging of seismic shot holes, stratigraphic tests, and core holes is readily accomplished under the scheme. Admittedly, the control obtained in ordinary seismic surveys can be considered reconnaissance only, when applied to uranium exploration, but valuable information can still be obtained. Such information can be acquired with little additional cost, as the major expenditure, that of drilling the hole, already has been made. No delay is encountered in the field operations of the seismic crew, since the logging unit can work between the drills and the shooting crew. Figure 3 illustrates a typical field operation in which the logging unit is mounted on a power wagon and is shown logging a hole while the seismic recording truck is laying out cables preparatory to shooting the next spread.

Century's uranium exploration experience has been confined chiefly to an application of well loggin, as shown in the petroleum industry, to uranium exploration. Therefore, a general discussion of this technique and instrumentation and their applications will follow.

A logging instrument has been designed by Century Geophysical Corp. that allows for the simultaneous logging of natural gamma ray activity and electrical resistance of the rock surrounding a bore hole. This instrument, called the Gamma-R Logger, is illustrated schematically in Figure 4.

The gamma ray portion of the subsurface instrument consists of a Geiger counter detector, pulse shaper, and power supply in the subsurface instrument. A Geiger counter is used as a gamma ray detector because of its simplicity and stability. Sensitivity approaching that of scintillation detectors is obtained by the use of a bundle of small counter tubes within the instrument. The sensing length is six inches.

A mono-electrode resistance measurement is used, as the relative values only of rock resistance are necessary and as a high degree of vertical resolution is required. The resistance measurement is telemetered along with the gamma ray signal over a single-conductor logging cable. The circuit is such that leakage requirements and the length of cable are not critical. At the surface, the two signals are separated and fed through appropriate amplifiers, pulse shapers, and counting rate meters, and then recorded on a dual Brown recorder. All power is derived from a 115-volt, 60-cycle, gasoline-driven generator. The gamma ray portion has a full-scale linear calibration from 10 to 10,000 cps in 10 decade steps. Six time constants are available, covering the range of 0.5 to 16 seconds. The selection of the constant is dependent upon the counting rate, logging speed, and precision of measurement required so that the statistical variations will be within the allowable limits of error.

A profile of typical logs from the Colorado Plateau area is shown in Figure 5. These logs, taken in a series of holes approximately 1,500 feet apart, illustrate the type of correlations that can be expected between lithology and the resistance log, as well as the correlation and assay of a mineralized zone that is made possible by the gamma ray log.

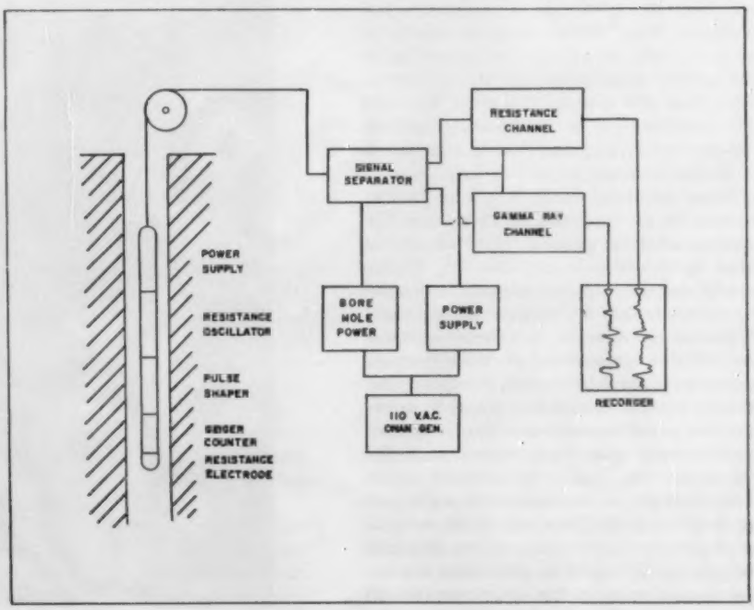
Units of this design have been proven in the field to have the required sensitivity and, of almost equal importance the stability necessary to withstand the rugged field, transportation, and temperature conditions inherent in exploration work. Century Geophysical Corp. has six of these units working on a contract basis for major mining and petroleum companies in the United States and Canada. A typical installation is shown in Figure 6. A boom arrangement makes it possible to position the logging tool conveniently over the hole. An accessory tripod arrangement is also available to permit the logging of holes that are beyond the reach of the boom arm.

In such a logging truck the generator, driven by a power takeoff from the truck engine, provides the power for an electric motor driven hoist and the electronic instrumentation. A measuring sheave in the boom assembly provides an accurate measurement of depth and, by selsyn drive, advances the recording chart. Chart speeds of 10, 20, and 50 feet of hole to one inch of chart are used. Normally, 3,000 feet of cable is carried, and hoisting speeds in the range of 2 to 100 feet per minute are available.

The instrumentation, because of oil well logging design, is capable of operations to 10,000 feet in depth and at temperatures in excess of 200°F., if desired. The logging unit is a one-man operation and, because of this fact, a front-end winch is used and other safety precautions are taken to insure the operator's being able to "get home" alone. The safety of the operator cannot be

FIG. 6. *Typical logging truck in operation with boom assembly.*

FIG. 4. *Block diagram of Gamma-R logging system.*



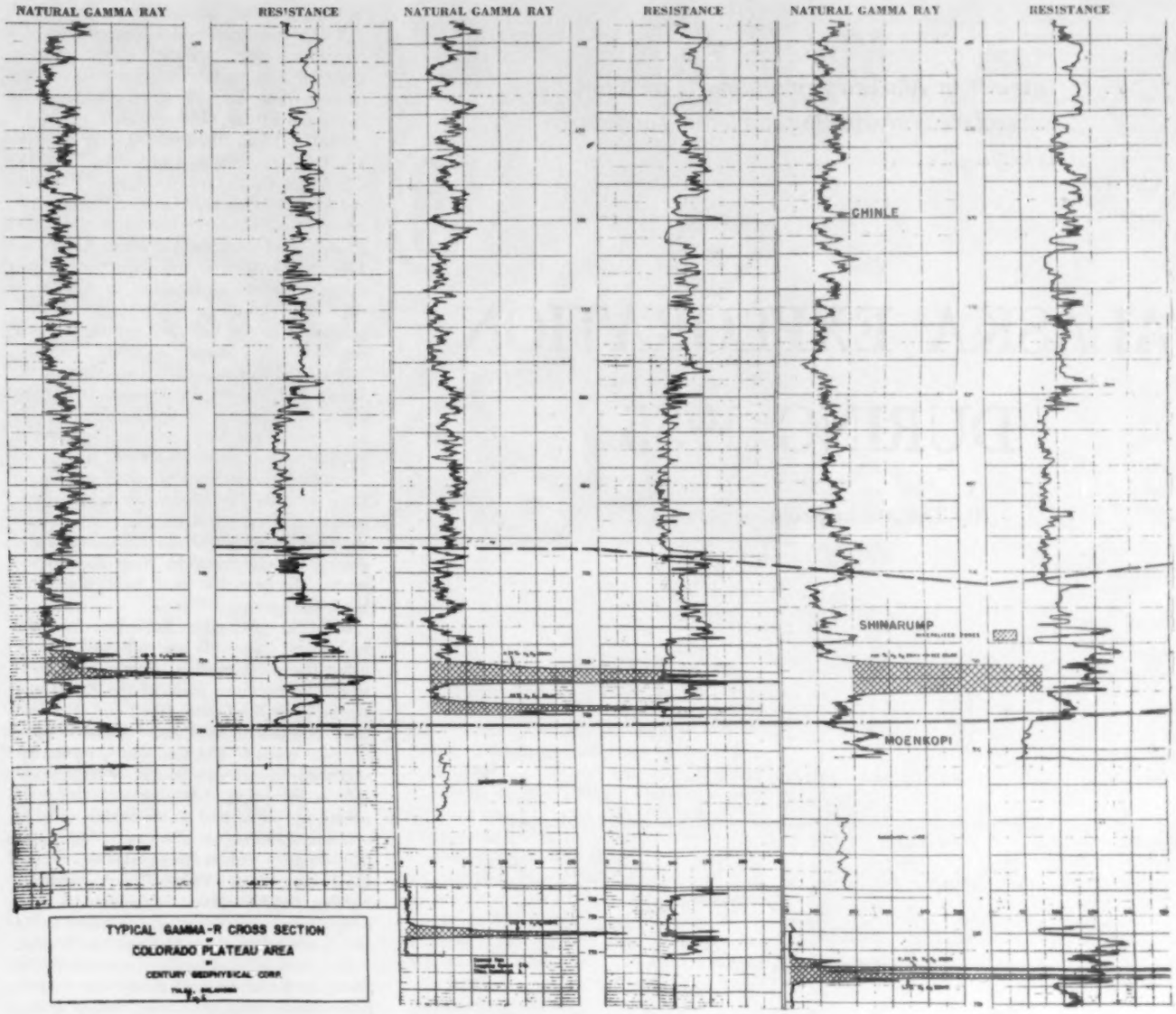


FIG. 5. *Gamma ray—resistance log correlation.*

stressed too greatly. There is considerable risk in traveling over mountainous terrain with few or no roads, as well as in being caught in the extremes of weather often encountered in the remote areas where these units operate. A four-wheel-drive vehicle is considered mandatory.

In a typical logging operation integrated with a seismic operation in which all seismic shotholes are logged a normal day's operation involves logging from six to 15 shotholes. This number of holes is normally required for a day's shooting in this area and represents no loss of time for the seismic crew.

When a radioactive anomaly is encountered, it is necessary to know what percent uranium oxide has been detected, and whether or not the source of the anomaly can be considered to be an ore body. Unfortunately, a measurement of radiation intensity does not necessarily yield information directly related to ore concentration, since such effects as radium-thorium ratio, inequilibrium, and ore type will materially change any calibration factor. However, for a known area, the proper use of gamma ray logs and calibration will allow a radiometric assay value to be obtained which agrees with chemical analysis within approximately 15 to 20 percent.

SUMMARY

The personnel, concepts, instrumentation, techniques and philosophies developed in petroleum exploration are readily adaptable to and extremely useful in exploring for radioactive minerals. Petroleum and uranium exploration can be efficiently combined, in many sedimentary areas. The desirability of such a marriage is self-evident.

The course of world events, as well as economic and political developments, demand that we obtain the optimum from our mineral exploration talents and abilities, regardless of what the mineral may be. The need exists to pool our experience, talents and energies to attain this objective.

Acknowledgements

The authors wish to acknowledge the Contributions of C. W. Zimmerman in the instrumental development; of Archie Nicol for assistance in field operation techniques, and of the Atomic Energy Commission, Climax Uranium Co. and Rocky Mountain Uranium Corp. for their permission to use information obtained in actual field practice.

Interest in Alaskan exploration is reviving. Several wells are drilling and leasing activity is high.

ALASKA EXPLORATION DURING 1955

By The Alaska Scouting Service

LEASING AND DRILLING IN ALASKA

NEARLY two million more acres leased, two deep tests and a continuation of a watch-and-wait attitude on the part of most of the major oil operators in the States—these have been the exploration developments in Alaska during 1955.

Shell Oil Co., Richfield Oil Corp., Standard Oil Company of California, Ohio Oil Co., Union Oil Company of California, Sunray Mid-Continent Oil Co. and Phillips Petroleum Co. hold large blocks on the Kenai Peninsula in Cook Inlet south of Anchorage (see chart). Each of these companies have either added to its holdings in Alaska, or have had representatives, geologists or geophysicists in the territory during the past summer.

Shell Oil had four crews working in the Kenai and Alaska Peninsulas. One helicopter-transported crew operated on the southern Kenai Peninsula, while another worked from a small boat along the shoreline. Two crews worked in the Becharof Lake area on the Alaska Peninsula across from the Kenai, and later in the summer Western Geophysical Co. of America did marine seismic work in Wide Bay to the south. It is here that Shell holds a sizeable block of options.

Richfield operated by helicopter from the mid-Kenai Peninsula and followed this by using the same marine seismic equipment along the northern coast of the Kenai and across Cook Inlet. Both Shell and Richfield used equipment that acted as a floating Shoran station. Thirty-six trace marine seismograph instruments and 24 trace portable seismograph instruments were transported by barge and water-taxis.

General Petroleum also used a helicopter in the upper Yukon River territory where the Porcupine and Yukon Rivers converge, northeast of Fairbanks. It conducted a general preliminary study of the river basin which extends east to the Canadian border.

Standard of California exemplifies the watch-and-wait attitude most of the majors have shown toward Alaska. While it has gone forward and gotten a development contract from the government, it did little more than make a preliminary survey of the geology in the Kenai and Alaska Peninsulas. In 1954, it did seismograph work in the southern Kenai Peninsula. Under its development contract Standard can hold 250,000 acres out of a total of 750,000 acres in the southern Kenai Peninsula. For this it had to spend $150,000 during 1955 for exploration, and will have to spend $100,000 each year until the spudding date for the first well set at July 1, 1959.

Phillips Petroleum was the first company to be awarded a development contract. It is the only major operator who in 1955 actually put down hole. On the 1,063,884 acre block in the Katalla-Yakataga district which it was awarded under the development contract in 1953, Phillips bottomed its second hole in June at a total depth of 10,013 feet. No commercial oil was recovered although oil sands were encountered and samples from them were of high quality crude. The hole was plugged and abandoned

This is area in which Phillips is drilling. The Phillips Petroleum Co. and Kerr-McGee Oil Industries, Inc. Sullivan No. 1, located on unsurveyed land in what would be approximately the NE-1/4 Sec. 9, T. 22 S., R. 21 E., CRM, was spudded on June 19, 1954, and drilled to a total depth of 10,013 feet. It was plugged and abandoned on Dec. 28, 1955. Preparations are being made to drill Sullivan No. 2 in a location approximately 1,200 feet south of No. 1. (All photos used in this article courtesy of The Alaska Scouting Service).

Havenstrite Oil Company's Iniskin Unit Operator Well No. 1. Spudded Aug. 4, 1954 and suspended for winter Oct. 25, 1955 at 9,745 feet.

Aledo Oil Co. and Alaska Oil 7 Gas Development Company's cable-tool rig 125 miles northeast of Anchorage, spudded Sept. 20, 1955 and suspended for winter Oct. 14, 1955 at 3,060 feet.

in December after a long series of tests. The company now plans to drill at a third location 1,200 feet south of the second hole. (The first was a stratigraphic test abandoned as a dry hole in May 1954 at a total depth of 4,837 feet). Nine more exploratory wells are called for by the contract within 10 years and Phillips has already met the condition of having spent more than $1,200,000 prior to June 30, 1956.

The other deep test was put down by the Havenstrite Oil Co. on the Iniskin Peninsula across Cook Inlet from the Kenai. It went to 9,745 feet before it was suspended due to heavy winter weather. Indications were favorable enough so that plans have been made to continue drilling next spring. This is Havenstrite's second attempt to find oil in Alaska. In 1936, it drilled its first hole on the Iniskin Peninsula before abandoning it as dry at 8,700 feet.

Three local companies continued to drill during 1955. One hundred and twenty-five miles east of Anchorage a cable-tool rig pushed down to 3,060 feet in the first of two wells planned by a Stateside independent, the Aledo Oil Co. of Fort Worth, and the Alaska Oil and Gas Development Co. of Anchorage. Progress has been slow, but results have been encouraging.

At Houston, just north of Anchorage, the Anchorage Gas & Oil Co. drilled to 2,100 feet alongside an earlier gas well. And a few miles south, the Alaska Gulf Oil & Gas Co. drilled to 3,855 feet before abandoning. A Schlumberger to 3,849 feet gave a small show of gas at 1,700 feet.

Sum total for 1955: Increased activity, no oil. However, oil is known to exist in many parts of Alaska in seepages and oil shales. A small refinery was operated between 1902 and 1933 in the Katalla-Yakataga district (where Phillips is now drilling), which used 154,000 barrels of crude produced from 18 shallow wells. Between 1943 and 1955 the U.S. Navy spent $36 million drilling 35 test wells ranging from 2,400 to 11,000 feet north of the Brooks Range in Naval Petroleum Reserve No. 4. A small-sized oil field was discovered, as was the Gubik gas field lying partly within the Reserve and partly in Public Land Withdrawal No. 82. Estimates put Gubik's dry-gas reserve at 300,000,000 mcf daily.

In October 1955, Secretary of the Interior McKay asked Congress to decide whether PLO No. 82 should be opened to private exploration. Several companies have indicated interest in going into this area, and, should Congress decide to open it, leasing activity which has heretofore been concentrated in the Kenai Peninsula-Cook Inlet area is expected to shift to the north.

Acres under lease:

Shell	290,000
Richfield	80,000
Standard of California	250,000
General Petroleum	34,000
Union and Ohio (jointly)	254,000
Sunray Mid-Continent	128,500
Phillips Petroleum (Kenai Peninsula)	50,000
Phillips Petroleum (development contract)	1,063,884

TOTAL: Nearly two million acres leased in 1955.

«

Church, sugar mill and plantation in the Province of Camaquey, set in a picturesque park typical of industrial installations in Cuba

Fourteen seismic, gravity, surface geology and core drilling parties conducting intensive studies. Nine wildcats drilling. Aerial work planned.

CUBAN OIL SEARCH

By Ruth Sheldon Knowles[1]

CUBA'S $35 million exploration program is off to such a vigorous and varied start in early 1956 that as one of the participating oil company executives concluded, "The question marks about Cuba may turn into exclamation marks this year!"

Here's the picture he found exciting:

Nine important wildcats seeking sedimentary production drilling or scheduled for the first quarter of 1956 only two less than *all* important wildcats drilled in 1955! One wildcat with a good show of oil and gas indicating a possible new shallow field of good grade oil.

Six seismograph crews working both on and offshore and a seventh readying; two gravity crews starting, two just finished; five surface parties detailing areas; one core drilling program in progress, two just finished; aerial mapping being done and a flying magnetometer program scheduled.

The majority of companies, planning to drill as fast as prospects are pin-pointed, meaning an accelerated exploration drilling program for the rest of 1956.

The Who, Where and Why adds to the significance of the above exploration statistics and planning.

The Who department is an impressive list—40 Cuban and U. S. oil companies, including six majors which have leased practically all of Cuba's 28 million acres plus great submerged shelves. Leaders in importance and immediacy of current exploration schedules are: Standard Oil & Gas Co.; Trans-Cuba Oil Co.; Cuban American Drilling and Exploration Co.; Siboney Drilling and Exploration Co.; Atlantic Refining Co.; California Exploration Co. (Standard of California); Kewanee Oil Co.; Benedum & Trees—Russell Cobb, Jr.; Cuban Gulf Oil Co.; Shell Oil Co.; and Cuban Sulgraves Oil Co. (For location of all companies' exploration concessions see special color activity map in October, 1955 WORLD PETROLEUM.)

Where? Present exploration and drilling cover every Province of Cuba—east to west and north to south, on shore and off; sketchily, of course—only the "high" spots being hit, but every area and every geological theory is being given preliminary attention. Cuba is a geological smorgasbord offering something tempting to every type of scientific appetite.

Why? The oil sportsmen are not fishing Cuban waters for sardines. They are after big-game fish—of a size comparable to those already landed in the U. S. Gulf Coast, Mexico, Trinidad, Venezuela and Colombia. Recent discoveries in Cuba have jolted the oil world into awareness of what such famous apostles of exploration thinking as Wallace Pratt and Dr. E. DeGolyer have been preaching for years—that Cuba is a great unexplored oil province in that vast land-locked body of water—the Caribbean Sea and the Gulf of Mexico, which is the Western Hemisphere counterpart of the Eastern Hemisphere's prolifically oil rich Mediterranean associated inland seas.

As Wallace Pratt points out in "World Geography of Petroleum," the lands surrounding the Caribbean Sea and the Gulf of Mexico and the shallow-water margins of the seas themselves promise, with the exception of the Middle East, to "yield more oil eventually than any other single province on earth."

"It is not without significance that the earth's two greatest mediterranean areas—of 'seas in the midst of land'—should also be the sites of the earth's greatest known petroleum provinces," Mr. Pratt reflects. "Typically negative mobile sectors of the earth's crust, squeezed and depressed between the rigid positive buttresses that constitute the central framework of the adjoining continental masses, these areas of land-locked seas—major earth features

Upper Eocene white limy shale quarry south of Vertientes in southern Camaguey Province. This is the area of greatest current interest to Siboney Exploration and Drilling Co. who have started their first wildcat on the coast of southern Camaguey, near Santa Cruz del Sur.

This small key in offshore waters about 15 miles south of Santa Cruz del Sur is typical of many crushed shell hard land keys in the shallow southern waters which Stanolind believes can be used as drilling bases and may make Cuban offshore drilling operations cost little more than mainland drilling.

[1] *See also* World Petroleum *March 1952, September 1954 and October 1955 for previous articles by Mrs. Knowles detailing earlier reconnaissance and development work in Cuba. All photographs accompanying this article are reproduced through the courtesy of J. C. Shields II, geologist for Siboney Exploration and Development Co.*

persisting through much of geologic time—have provided an ideal environment for the generation of petroleum."

Mr. Pratt feels that commercial oil fields in Cuba, the other islands in the West Indies and Central America, between Mexico and Colombia, have not yet been found simply because their "favorable evidences of petroleum have never been systematically explored." Now that oil finders have become aware of this, the Caribbean rush is on. With Cuba leading the list, oil seekers are turning their search to Jamaica, Haiti and Guatemala. The last half of this decade may well go down in oil history as the unfolding of an exciting Caribbean Chapter.

It is certainly coincidental that as G. Moses Knebel, exploration manager of Jersey Standard and president of the American Association of Petroleum Geologists, points out in his research on "The Habitat of Oil," major oil discoveries have come in 10-year cycles with the last big peak coming in 1948. This rhythm of big oil finding is due to peak again by 1958 or so and due to programs already underway in the West Indies and their physical ease of exploration, the West Indies could qualify more quickly as the immediate source for big discoveries than a great many other new, unexplored areas of the world currently in initial stages of exploration.

Of all unexplored parts of the Caribbean, Cuba has the greatest surface indications of the occurrence of petroleum—actually, as Dr. DeGolyer points out, it has more physical evidences of petroleum than any other country in the world.

To complete this mental aerial view of the "Why" of Cuban exploration, Cuba contains all the geological systems accounting for 87.4% of total oil found in free-world major oil fields. In Mr. Knebel's research already referred to, he studies all free-world oil fields containing over 100 million barrels ultimate production. These big fields total 82½% of free-world ultimate reserves discovered to date. He found the Cretaceous and rest of the Mesozoic system rates first place for productivity of oil with 52.7% of all oil studies; Mio-Oligocene with 28.7%; and Eocene-Paleocene with 6%. Discovery of production in all these systems are the goals of Cuban exploration and there are no known limitations to preclude the discovery of major oil fields within Mr. Knebel's definition.

All these points are the generalities which glitter in over-all thinking about Cuba's potentialities. A descent from the clouds to a close-up view of what is being done on the ground and below it to prove these generalities, doesn't make them glitter any the less.

Of keenest interest, as it is the largest single exploration commitment on the island, is Stanolind Oil & Gas Co.'s program. In September, 1955, Stanolind committed itself to spending $10 million during the next five years to earn an undivided 50% interest in some 12 million acres of concession rights managed by Cuban Venezuelan Oil Voting Trust and Trans-Cuba Oil Co. It is too soon, of course, to evaluate the concessions, but the rapidity and enthusiasm with which essential first stages of exploration are being carried out is indicative of the belief that a real oil province is being explored.

Their concessions lie in Cuba's three untested sedimentary basins, with over half the concessions off shore on the southern shelf. Consequently, Stanolind is pursuing off shore exploration as vigorously as on shore. Two Western Geophysical Co. seismograph crews are currently working—one onshore and one off. The land-based seismograph party has been working since December, 1955, and will continue until the seismic phase of exploration is finished. The offshore seismograph party is working the Gulf of Guacanaybo and will continue exploration activities for several months. It is understood that they have been getting excellent reflections, as have Cuban American and Trans-Cuba in their work, as far as it is possible to tell at this stage.

There has not yet been enough drilling in Cuba to accurately interpret seismograph pictures. Pictures being found now by Stanolind and others, of necessity have to be interpreted on the basis of past experience in other areas.

As one outstanding geophysicist points out, the value of seismograph programs in such untested areas is primarily to locate major structures. Big structures will stand out even though detailed interpretation of the seismograph picture would most likely have to be revised after drilling. As drilling progresses and more velocity surveys are available, all work can and will be reinterpreted to lead to new prospects.

Stanolind's approach is the sound and obvious one of looking for simple oil first. Over 80% of the world's major oil fields

Overturned Eocene beds south of El Cristo, on the highway to Santiago in southeastern Cuba. This is in the general area of part of Stanolind concessions where a large surface structure has been discovered.

A magote in Pinar del Rio Province, western Cuba, showing Jurassic limestone overlain by Lower Cretaceous. Under proper conditions, this thick massive Jurassic limestone could form an excellent reservoir for oil. The Pinar del Rio area is of greatest interest to Atlantic Refining Co. and is where its major exploration activities will be carried out.

FOLD-OUT MAP ▶

have been found in anticlines, a great many of which were found on simple surface geology alone. There are a number of large anticlines in southern Cuba which may turn out to be as simple an approach to finding big oil as has been the case elsewhere in the world.

Southern Cuba lends itself to the so-called "simple" approach because, unlike the highly folded and faulted north coast, southern basin areas are comparatively unaltered, showing minimum disturbance. Generally speaking, surface work in the north is of little value as surface structure has little relation to structural conditions below. However, in the south, Stanolind as well as others, are finding a great deal of significant new information. This is not surprising as up to now the only real surface work in Southern Cuba was done years ago by the United States Geological Survey in small areas looking for minerals, not oil.

In order to understand the programs of Stanolind and others in south Cuba contrasted with the geological approach of companies in the north (to be discussed subsequently), it must be kept in mind that until 1954 the cursory oil search was concentrated along the western portion of the north coast which is highly folded, faulted and contains large areas of serpentine with active seepages. Cuba is divided into four structural areas separated by three large sedimentary basins. The general structure of the island is broadly anticlinal and the structural axis nearer the north coast is parallel to the geographical axis.

Mrs. Dollie Radler Hall, consulting geologist of Tulsa and former administrative geologist for Amerada Petroleum Corp., has made one of the most intensive and comprehensive studies of Cuban geology. She points out, "There is evidence that some form of petroleum is present in every province of Cuba. There is known to be a stratigraphic section of at least 2500 feet of Jurassic, 20,000 feet of Cretaceous and 10,000 feet of Tertiary sediments. Sediments that can be seen and measured show rocks of good source material as well as those that have excellent reservoir conditions. There is some evidence that reef accumulation as well as salt domes exist."

Prior to the 1954 discovery of a stratigraphic trap of heavy oil in an Upper Cretaceous sandstone at Jatibonico, all Cuban oil had come from serpentine, a rock of igneous origin or from limestones and dolomites closely associated with the serpentine. This oil was produced in three fields—Bacuranao, Havana Province, discovered in 1864; Motembo, Las Villas Province, discovered in 1881; and Jarahueca, Las Villas Province, discovered in 1943.

Mrs. Hall comments, "The oil obviously did not originate in the serpentine. Therefore it is thought that the oil now found in the serpentine was originally trapped at depth and was carried to its present position during the igneous activity that disturbed the original reservoir. If this is true, there should be large reservoirs at depth that were not disturbed by the igneous activity or are trapped at depth."

Looking east southeast from a high point above the North Jatibonico River, this panoramic view shows terrain in central Cuba's newly-discovered Tertiary basin of as yet unknown thickness, but already drilled to 10,000 feet. Cuban American Oil Co. with the largest holdings in the basin, is currently drilling a test which has had oil and gas shows.

This complex geological situation has divided geological thinking into three schools —those preferring the south, those preferring the north, and those to whom both types of search appeal.

In Stanolind's program in the south, the explorers are completing aerial mapping as a basic guide to detailed surface work. They also plan to use the flying magnetometer to coordinate with the aerial maps. They have already done some core drilling and plan more. They do not plan to use gravity, although the general gravity reconnaissance done for CVOVT (see accompanying map) was one of the principal factors influencing them to enter Cuba. The other tools in the exploration kit plus all-essential drilling will be used, which are necessary in any event to be able to properly evaluate the meaning of gravity reconnaissance.

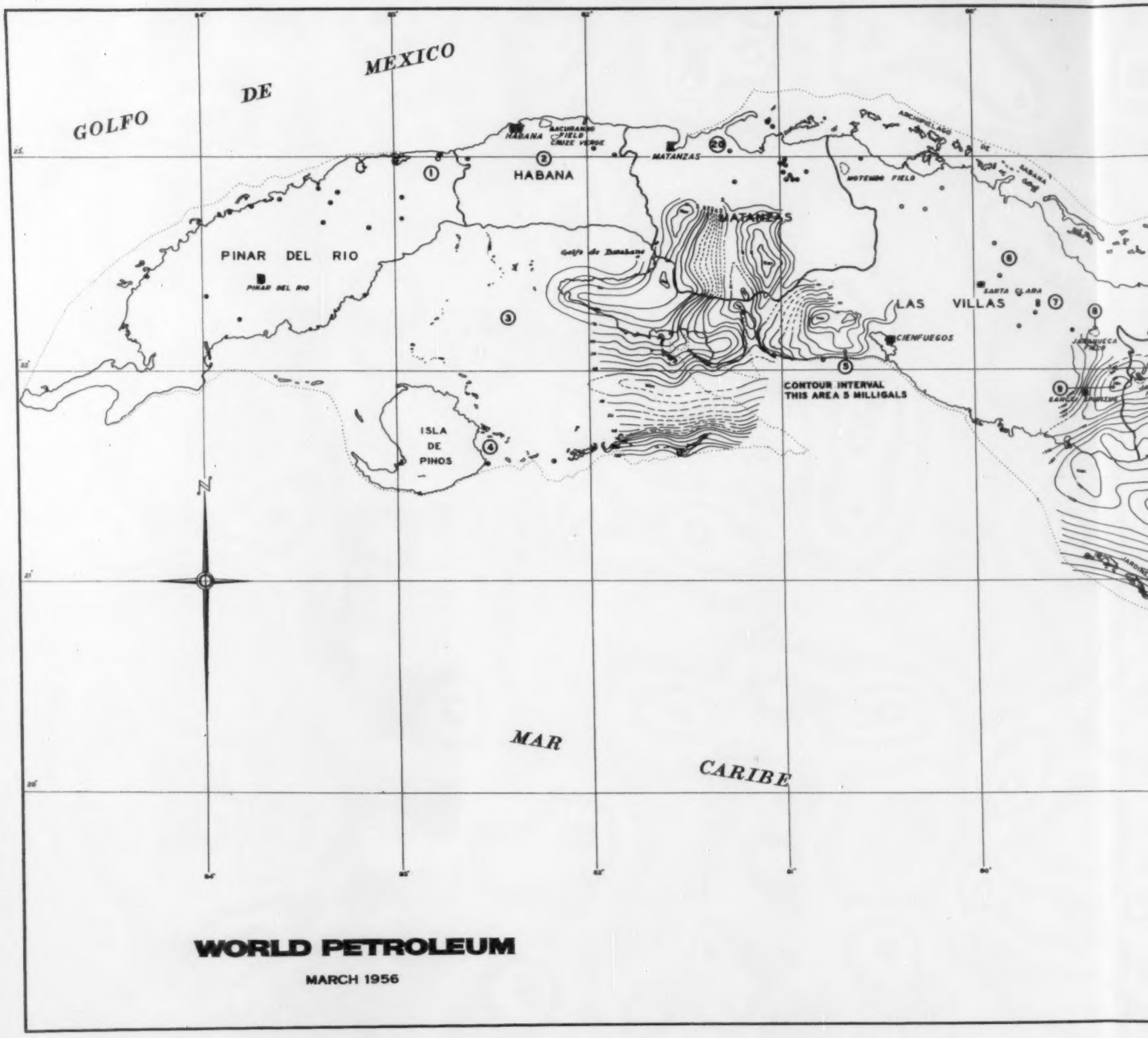
Stanolind plans to drill as soon as it has a good prospect ready and at the present rate the first wildcat should be drilling during the first quarter of this year. Stanolind is thinking in general terms of 12,000 foot tests as there are so many unknown factors in regard to thicknesses of sedimentary sections.

Stanolind does not believe that offshore drilling should be relatively any more expensive than onshore work. The waters of the southern shelf are quite shallow and studded with crushed shell, hard land keys which could be used as bases. Also it should be a simple matter to sink piles in the limestone reefs. These favorable physical factors combined with today's offshore techniques are why Cuba's offshore development can come as quickly as the mainland.

Trans-Cuba Oil Co. has made the greatest contribution to date of exploration knowledge of southern Cuba. It is currently drilling the first exploratory test in the big Cauto basin in eastern Cuba. One of its four tests drilled in the Jatibonico basin last year revealed that the Tertiary is more than 10,000 feet in depth there as the bit was still in Tertiary when the well was bottomed. This is one of the most significant developments in Cuba and is responsible for a great part of the current interest. In such a thick marine-sediment-filled basin, with ample proof on the surface that porosity can be expected, geologists believe there is bound to be an abundance of oil to be found. Before this well, a majority of geologists had wrongly guessed that southern sedimentary basins had only thin sections of sediments.

Trans-Cuba is a Cuban oil company formed by leading Cuban sugar men, industrialists and bankers who had the courage to start looking for Cuba's oil before the current boom generated. In a bold action, unprecedented in Latin America and motivated by their desire to free Cuba from its dependence on a one-crop-sugar economy, they made a $3 million contract to acquire half interest in 17 million acres of concession rights in the three southern basins and shelves held by 24 companies managed by Cuban Venezuelan Oil Voting Trust. CVOVT, organized in 1948 and headed by Warren Smith, former president of Pantepec Oil Co., of Venezuela, has had the same faith in the discovery of Cuba's oil resources that Cuba's discoverer did that the world was round. CVOVT and Trans-Cuba together have been the yeast in the exploration loaf of bread now ready for the oven.

Trans-Cuba's exploration program is under the direction of oil-finder Henry E. Linam, independent oil producer and former president of Standard Oil of Venezuela.



WORLD PETROLEUM

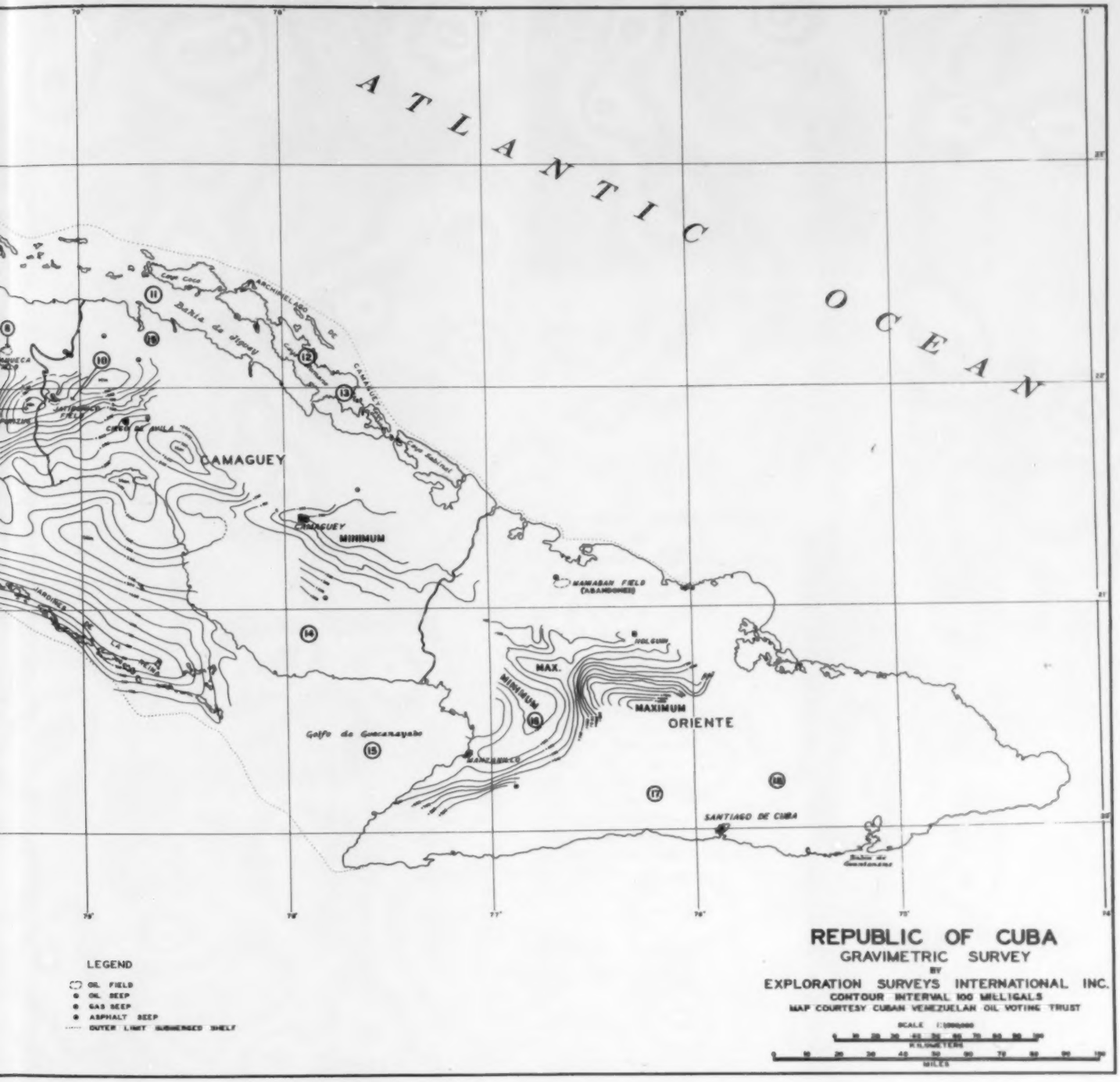
MARCH 1956

This gravity map prepared by Exploration Surveys, Inc. under the direction of Frank Fisk (now president of Subsurface Studies Inc.) was the result of 21 gravity meter crew months and seven magnetometer crew months in Cuba in 1951-2. An area of approximately 17 million acres was surveyed by this broad regional reconnaissance. Geophysical data obtained by this survey has indicated all of the types of anomalies associated with oil production in other areas of the Gulf Coast exist in Cuba. This reconnaissance survey was one of the most important factors in obtaining current exploration in Cuba and helped change exploration thinking as to Cuba's potentialities.

Cuba's shelf area is indicated by the dotted line and both north and south shelves will see as much activity this year as mainland drilling with gravity and seismograph crews doing reconnaissance and detail work for Stanolind, Sibaney, Standard of California and Atlantic Refining.

The location of currently significant drilling and reconnaissance activity is shown on the map with numbers 1 to 20 in circles as follows:

1. Maria
stone.
2. Jersey
3. Sibon
4. Lee C
5. Cuba
6. Cuba
just fi
7. Union
8. Kewa
starti
9. Trans
Tertia
10. Cuba
below
11. Atlan
test v



LEGEND

- OIL FIELD
- OIL SEEP
- GAS SEEP
- ASPHALT SEEP
- OUTER LIMIT SUBMERGED SHELF

REPUBLIC OF CUBA

GRAVIMETRIC SURVEY

BY

EXPLORATION SURVEYS INTERNATIONAL INC.

CONTOUR INTERVAL 100 MILLIGALS

MAP COURTESY CUBAN VENEZUELAN OIL VOTING TRUST

SCALE 1:1000000

KILOMETERS

MILES

1. Mariel Petroleum Co. drilling below 2,000 feet, reportedly in limestone.
2. Jersey Standard gravity crew.
3. Siboney Drilling & Exploration Co. gravity work just finished.
4. Lee Oil Co. of Chicago gravity crew working on and off shore.
5. Cuban Sulgraves Oil Co. No. 2, 10,000-foot wildcat drilling.
6. Cuban Gulf Oil Co. 3,000-foot stratigraphic core drilling program just finished.
7. Union Aurrera Jarahueca Co. 4,000-foot test drilling.
8. Kewanee Oil Co. 5,000 to 7,000-foot exploration drilling program starting.
9. Trans-Cuba Oil Co. Sancti Spiritus No. 2 which found 10,000 feet of Tertiary section.
10. Cuban American Drilling and Exploration Co. Cristales No. 1 drilling below 6,000 feet in Upper Cretaceous with oil and gas shows.
11. Atlantic-Shell-Jersey Standard just finished seismograph work and plan test well.
12. California Exploration Co. (Standard of California) to start seismograph work.
13. Atlantic Refining Co. just finished seismograph work.
14. Siboney Drilling & Exploration Co. 5,000-foot test of Upper Cretaceous now drilling. Seismograph crew working in area.
15. Stanolind Oil & Gas Co. seismograph water crew working.
16. Trans-Cuba Oil Co. 10,000-foot test drilling in Tertiary below 4,000 feet.
17. Benedum & Trees-Russell Cobb, Jr. 6,000 to 10,000-foot test to start in March.
18. Stanolind Oil & Gas Co. seismograph crew working.
19. Dr. Antonio Iglesias 5,000-foot test on Atlantic Refining Co. farmout now drilling.
20. Cuban Oil Corporations (Pacific Petroleum) core drilling program just finished.

With Jones Brothers Drilling Co., of Shreveport, as contractors, Trans-Cuba drilled half of all exploration footage in 1955 in search of non-serpentine production. They drilled a 3703-foot well at Jucaro on the south coast of Cuba's central basin (also referred to as the Jatibonico basin); a 4727-foot test, Algodones No. 1, halfway between Jucaro and the Jatibonico oil field (Cuba's first sedimentary production discovered in 1954); a 10,118-foot test, Sancti Spiritus No. 1, about 10 miles southwest of the town of Jatibonico, which began and bottomed in Tertiary proving the section is of great unknown thickness in the basin; and a 7850-foot test, Sancti Spiritus No. 2, 4½ miles west of No. 1, abandoned last December 12 primarily because of a fishing job. This well was still in Tertiary and had a thicker section than had been anticipated. In the opinion of Harry Wassall, consulting geologist of Havana and former Cuban Gulf geologist, who has made a comprehensive study of this new Tertiary basin, it now appears that the basin extends south and over the shelf area.

Although none of these wells found oil, they have been of the greatest scientific importance in developing information as to the most favorable areas in the basin. The wells have been left so that it will be possible to drill deeper later if additional information indicates this advisable.

On the basis of detailed gravity work by Subsurface Studies Inc. (headed by Frank Fisk who conducted the original reconnaissance gravity survey for Exploration Surveys) and a seismic high found by Rayflex Exploration Co., Trans-Cuba is now drilling the first wildcat on its holdings in the Cauto basin, Oriente Province, eastern Cuba. The wildcat, scheduled for 10,000 feet, and located about 15 miles northwest of Bayama, was below 4000 feet the first part of February. It started in what was apparently either Pliocene or Miocene and indications are that it may reveal a thick section of Tertiary in this basin as it was still in Tertiary at 4000 feet. This test is, of course, one of the most important wells drilled in Cuba. Its findings will be of great value in coordinating with Stanolind's exploration to the south.

Another important Oriente Province test is scheduled to start in March on a 400,000-acre concession east of CVOVT-Trans-Cuba's Oriente holdings. It is jointly owned by Benedum & Trees, of Pittsburgh, and Russell Cobb, Jr. of Tulsa. They are concentrating on surface geology and will drill the first of two large structures they have discovered. Famed 86-year-old wildcatter Mike Benedum is so enthusiastic about Cuba that he plans to personally be on hand for the spudding in of the first test. Operations will be handled by Russell Cobb, Jr., who says the company plans to import a large rig. The test is scheduled for from 6,000 to 10,000 feet.

Cuban American Drilling and Exploration Co., is doing highly significant work in the Jatibonico Central Basin on a 750,000-acre mainland farmout from CVOVT and Trans-Cuba. This group of California and Texas independents headed by Tevis Morrow, Herbert Klein and Grady Vaughn, drilled a 5,281-foot dry hole in 1954. Cuban American started an extensive seismograph program, using Rayflex. DeGolyer and McNaughton analyzed results, finding the quality of reflections good and stating that Cuban American's exploration program indicates geologic conditions in the central basin considered to be favorable for the occurrence of petroleum.

Cuban American has located several anomalous areas which give promise of having favorable structural and stratigraphic conditions for oil accumulation. Detail work on two of these shows they cover approximately 1,000 acres each and may have closure on the order of 300 to 400 feet. It is currently testing one of these structures 10 miles east of the Jatibonico field. This well, Cristales No. 1, was drilling below 6000 feet in the Upper Cretaceous in early February and it is planned to carry it to 7000 feet, if basement isn't encountered first.

Starting in Tertiary, the well went into Upper Cretaceous around 1500 feet. Between 2600 and 2750 feet they encountered 150 feet of oil and gas saturated limestone. The upper 20 feet tested gas estimated at better than 1,000,000 cubic feet a day and the remaining 130 feet was oil saturated but with low porosity. They plan to test the oil and gas zone, treating with acid fracture, and conceivably may have found a good shallow field. As tests indicate 30 gravity crude, this could be Cuba's first commercial sedimentary well of good grade oil.

Cuban American has staked a second location on another seismic structure about five miles northwest of Sancti Spiritus and is keeping two seismograph crews busy on its Central basin holdings doing additional reconnaissance and detail work.

Another extremely important test is being drilled in the Central basin by Siboney Drilling and Exploration Co. (Crescent Petroleum-Sterling Oil-Caribbean Associates). Spudded in early February, the 5,000 foot test is located on a surface, gravity and seismic high about 25 miles north of Santa Cruz del Sur on the southern coast of Camaguey Province. The goal is to test the lower Cretaceous limestone Seismic data indicate a major structure and suggests a thick sedimentary section.

This is the first prospect readied by Siboney following reconnaissance gravity work on its concessions by Exploration Surveys, Inc. and seismograph work by Advance Exploration Co. of Houston. A seismograph crew is now working. Siboney has been doing intensive surface work during the past year headed by J. C. Shields II, who has probably done more actual field work in Cuba than any other geologist.

Siboney is one of the largest concession holders in Cuba with approximately five million acres, principally in three large blocks—the Gulf of Batabano; south central Camaguey Province, both mainland and off shore; and the Cauto basin in Oriente Province. It has already done preliminary gravity surveys offshore in the Gulf of Batabano.

Another wildcat underway in Southern Cuba is testing an entirely different area and is the first wildcat in the Zapata Peninsula basin. Cuban Sulgraves Oil Co., formed by Col. Otis Seagraves and the late John L. Sullivan, of San Antonio, took a 160,000-acre farmout from CVOVT-Trans-Cuba. On the basis of CVOVT's original gravity reconnaissance work, Cuban Sulgraves started its first test last year, but a fishing job forced abandonment at 1705 feet, after reported oil shows in the Miocene. It is now drilling a second test, scheduled for 10,000 feet a thousand yards north of the first location.

Southern Cuba will probably be the scene of Cuba's first big oil strike, for as detailed above, more than half of the $35 million committed in exploration is dedicated to the southern areas. The companies operating there are drilling tests in all three basins and their policy is to follow up geological and geophysical exploration as quickly as possible with the drill—which, in the final analysis, is the only way oil is found.

Exploration in nothern Cuba falls into two categories—a predominantly major oil company effort both onshore and off—and a large group of small independents looking for serpentine production.

North Cuba advocates are Atlantic, California Exploration Co. (Standard of California), Shell and Jersey Standard. They all hold major concessions, primarily offshore. Atlantic and California Exploration acquired their north offshore holdings a year ago—with California Exploration taking the majority of concessions Cuban Gulf had just dropped. Atlantic, Shell and Jersey jointly hold an offshore concession which was about the only property retained by these companies following a stab at Cuban exploration between 1930 and 1947. During the past year they have been doing additional seismograph work and plan to start a well, possibly within the first quarter of this year.

North coast geology, particularly offshore, is "no place for a boy" as one major oil company executive phrases it. Offshore tests already drilled by Gulf and Shell prove this. However, they have been tantalizing enough to stimulate commitment of several millions of dollars in contemplated exploration and drilling. Current major company thinking is that previous tests is that previous tests were not drilled deep enough. California Exploration is planning a seismograph program on its newly acquired holdings. Jersey Standard is doing gravity work on the mainland, although it holds no concessions there.

Atlantic Refining has now the most aggressive major oil company program outside of Stanolind's. In addition to recently acquired large holdings offshore on the north coast, it has reacquired and greatly added

to its former holdings in Pinar del Rio Province, the western hook of Cuba. Scenically this is one of Cuba's most picturesque areas, due to the great magotes that dot the landscape like a herd of sleeping Brontosauruses. The oldest known sediments in Cuba are of Jurassic age and in Pinar del Rio Province a thick massive Jurassic limestone cut by a fine network of calcite veins quite soluble and cavernous forms the axial portion of the Sierra Rosario and Sierra Organos. Asphalt has been found in fossils in the Jurassic and under proper conditions this formation could form an excellent reservoir for oil. Atlantic's early drilling in this area was prior to the development of modern techniques of drilling through such cavernous limestone and its eagerness to reacquire former holdings is significant.

In addition to seismograph work on its north coast holdings, Atlantic has been reevaluating all its geological information. It is establishing an exploration staff in Cuba and plans a drilling program for this year.

Pinar del Rio may start popping even before Atlantic starts to drill, as The Mariel Petroleum Co., backed by sugar man Julio Lobo is drilling a test with a Cuban Government bailing rig near Mariel.

One of the most important north coast tests to date is being drilled by Cuba's most enthusiastic (and to date luckiest) wildcatter, Dr. Antionio Iglesias, discover of the Jatibonico oil field in Camaguey Province near Moron on an Atlantic Refining Co. farmout. Using the Cuban government National 75 rig, he is drilling a 5,000-foot test on a 1,000 acre block given him by Atlantic, who are also supporting the test with bottom hole money. Atlantic has done seismograph work in the area.

Cuban Gulf Oil Co., which entered the picture in 1947 at the time Atlantic, Shell and Jersey Standard withdrew, gave up approximately 750,000 acres of north offshore concessions in 1953 after drilling two tests, and acquired a like amount on the mainland in Las Villas Province where for the past two years it has been doing intensive surface work and a core-drilling program of 3,000—foot stratigraphic tests, as well as some seismograph reconnaissance. It is understood it plans a deep test sometime this year.

The rights to a depth of 4000 acres on about 100,000 acres in Gulf's block are held by a Cuban group, Union Petrolera Aurrera Jarahueca, which last year drilled three tests with numerous oil shows in the general area of Santa Clara and are drilling a fourth. This could open up a likely new area.

Kewanee Oil Company, of Philadelphia and Tulsa, has drilled two extremely interesting deep tests. In 1954 it acquired a ¾th interest in a 25,000-acre block including the Jarahueca producing field. In search of a reservoir at depth as the source of the serpentine production, it drilled a 7560-foot test which was in serpentine all the way and a 7285 foot test which penetrated the serpentine and is reported to have still been in Upper Cretaceous when abandoned. As the result of these findings it plans to move further out on the block and away from the old field to drill a number of 5000 to 7000 foot tests in search of the reservoir. In the old field itself Kewanee will continue to drill for serpentine production as it has already developed additional production from the 15,000 feet of shallow holes drilled last year.

Kewanee is expanding its concession holdings and plans a big exploration and drilling program this year. With three rigs in Cuba and a year's experience it has come up with the astonishing fact that it is able to operate its drilling rigs at about 30% less cost than the same operations in the states. Kewanee has trained Cuban crews and only an American toolpusher is necessary.

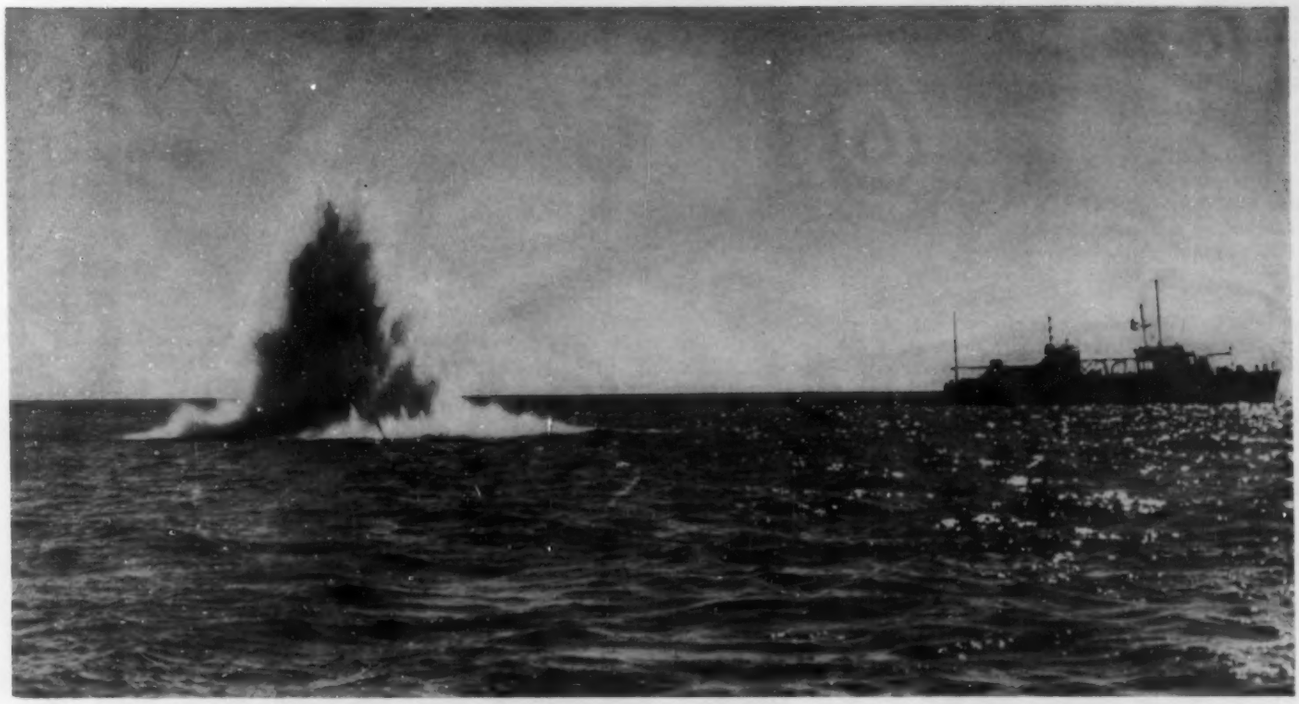
Cost-wise Cuba is the exception to all foreign operations. Drilling and exploration costs are no more than in the states and as evidenced by Kewanee, can be less. The reasons are simple, but in no place else does such a combination exist—no difficult terrain; plenty of highways, railroads and communications systems; ample good labor; close proximity to U. S. supply centers.

The search for serpentine production in Cuba proceeds at a surprising rate by a large group of independents, mostly Cuban operators with cable tool rigs. 1956 saw three important serpentine discoveries near Havana in the Bacuranao area. Ted Jones Enterprises of California drilled two wells about 12 miles east of Havana. Thomas Bess No. 1 was a marginal producer in the Serpentine at 3124 feet and has untested shows above. Thomas Bess No. 2, however, is flowing 125 barrels of 16 gravity oil a day producing from a dolomite pay zone at 2528 feet overlying a massive serpentine body. With serpentine above and below this could scarcely be considered the discovery of a sedimentary source reservoir. A third well four miles east is temporarily abandoned but had promising oil shows.

A half mile south of the Thomas Bess wells is the new Cruz Verde serpentine

Middle Oligocene reef south of Holguin, Oriente Province, in the Cauto basin area to be explored by Stanolind and Trans-Cuba. Trans-Cuba is currently drilling the first deep wildcat in the Cauto basin further south.

Marlstone basal Oligocene near the Cauto river west of Miranda, Oriente Province. Trans-Cuba is currently drilling the first deep wildcat in this unexplored Cauto basin.



Scenes similar to this underwater seismic explosion will be seen in Cuba during forthcoming offshore exploration.

field—three wells drilled in early 1955 producing around 60 barrels of 28 gravity oil at 1055 feet.

Oro Negro Oil Co. drilling nine miles southeast of Cruz Verde has apparently opened up another serpentine producing area with a 3300 foot well which has three promising oil zones being tested.

Canadian Astoria Minerals is drilling a series of shallow wells in a serpentine area just west of the town of Matanzas.

In the Motembo napatha field, Cuban independents drilled a total of 44,000 feet of hole in shallow tests, bringing 1955's total exploration footage in search of serpentine oil to 105,000 feet, twice as much as was drilled in search of sedimentary production. This, of course, is due to the fact that geological and geophysical programs to locate structures are just now getting underway. Even so, after so many years of inactivity, a total 160,000 feet of exploration hole in one year looks as good to Cuba as a 6-inch rain would now to an Oklahoma farmer.

A handful of independent companies with holdings scattered throughout the island are in various stages of organization, planning and exploration. Perla Negra Oil Co., with some three million acres, whose holdings were formerly under option to Pacific Petroleum, is reported to be forming a new company with outstanding oil and banking interests which would make it one of the biggest operators on the island. Americuba Petroleum Corp., subsidiary of Reiter-Foster Oil Co., with holdings of half a million acres, has already done some drilling in the Jarahueca oil field and is planning an exploration program for its other concessions. Cuban Oil Corp. (Pacific Petroleum et al) has finished a core drilling program south of Cardenas, Matanzas Province and will probably drill several 3000-foot tests on its concessions there. This group drilled a joint 4500-foot test in 1955 with Cuban Colombian Oil Co. near Jatibonico which helped establish the thickness of the Tertiary basin. Lee Oil Co. of Chicago has a Subsurface Studies Inc. gravity crew working on its Isle of Pines concessions.

Cuba's 1954 discovery, the Jatbonico field which sparked the current boom, now has over 20 wells producing about 1200 b/d of 16 gravity crude. Cuban Canadian Oil Co. (American Leduc) and two Cuban companies, Union Petrolera Aurrera Jarahueca and Inversiones Petroleras Versailles, own divided interests in this field. The crude is being sold to the 8,700-barrel Esso refinery in Havana.

When the oil comes, there will be no lack of refining capacity to handle it initially. Texas Company is going to construct a 20,000-barrel refinery in Santiago de Cuba. Esso plans to enlarge its Havana refinery capacity to 30,000 barrels and Shell plans a new 35,000-barrel refinery in Havana. A group of Florida and Cuban independents plan to construct a 5,000-barrel refinery at Cienfuegos on the south coast.

When the oil comes, there is also a hungry 55,000 b/d domestic market ready to gobble up that amount and three times more to carry out banked-up industrial plans in this island now dependent upon imports. The domestic market is one of Cuba's great attractions to the explorers.

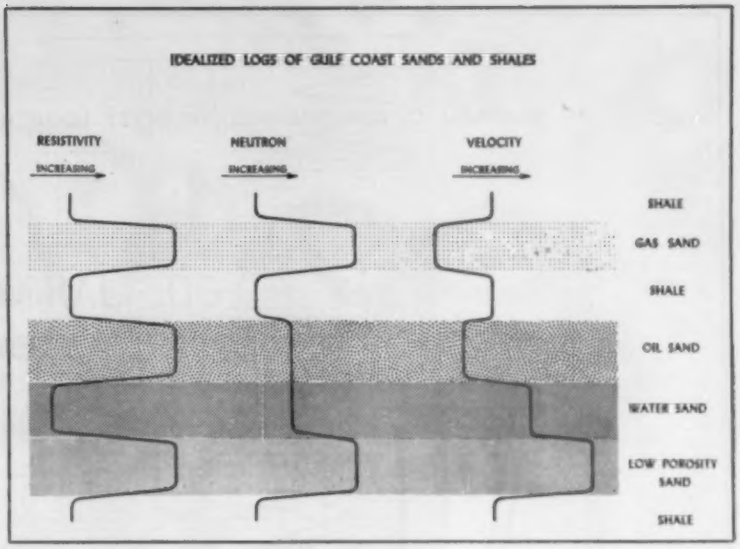
Among the other non-scientific plus values not already mentioned are the most favorable petroleum law outside the U.S. and the best political climate of any foreign country. A substantial private enterprise Cuban oil industry has developed, which is unique in foreign oil countries. Coupled with Cuba's democratic government and the highest standard of living in Latin America, this is an insurance policy against nationalistic oil grabs.

Who owns the oil is as important a question in foreign exploration as where is the oil. How this can influence oil thinking is well illustrated by the exploration manager of a big oil company who recently recommended that his company turn down a most attractive foreign oil prospect. "I could guarantee to develop 100 million barrels of reserves," he said regretfully, "but I couldn't guarantee after we developed it who would own it." In Cuba there is no such question or even the possibility of it. The only questions are the ones we are used to in U.S. exploration—"Where's the oil and how much of it is there?"

The 1956 Cuban search for the answer to these questions is a far cry from the statement made four years ago by a major oil company chief geologist who turned down a deal on a great majority of the acreage under such active exploration today. "I can't find a geological peg upon which to hang my hat in recommending Cuba to management," he said. He could find plenty of pegs today and all of them not only have hats hanging on them, but there is a waiting line at the checkroom!

These idealized logs were prepared by Warren G. Hicks of Magnolia Petroleum Co. and are based on his study of numerous logs obtained in the Miocene belt of the Texas and Louisiana Gulf Coast. Generally, a similarity of correlation is recognized between velocity logs and resistivity curves. However, reverse correlations, as shown at right, are found in the sands of South Louisiana. Here the water sands commonly show less resistivity than the adjacent shales. Yet, as expected, the water sand velocities are higher than the shale velocities. When the velocity in a sand is lower than in the adjacent shales, and the resistivity is higher, according to Mr. Hicks this is exactly the condition we are seeking. He states that in the analysis of these sections a combination of high resistivity and low velocity in the sands, indicates that hydrocarbon saturation is almost certain to exist.

The idealized velocity log shown at right illustrates how oil or gas sands can be distinguished from water sands, from low porosity sands, and from shales. The resistivity curve does not differentiate between a gas, oil, or low porosity sand. The neutron log does not differentiate between a gas and low porosity sand or between an oil and water sand. Although this example is prepared from Gulf Coast data, the conditions portrayed here are believed applicable to other areas with similar sand conditions.



CONTINUOUS VELOCITY LOGGING

CONTINUOUS velocity logging, the newest seismic surveying technique, is proving itself to be a dependable test of sub-surface formations in the search for oil. Faced with the need for a more conclusive seismic interpretation, Magnolia Petroleum Company's field research laboratory announced the development of such a technique in July 1952. The method was needed to bridge the gap not filled by conventional well-shooting techniques.

Since the long-established technique of shooting near the surface and recording in the hole is not adaptable to continuous velocity logging, an entirely new development was required which was achieved by Magnolia and subsequently leased to Seismograph Service Corp., Tulsa, which offers the service to the industry. Through its world-wide operations, SSC, in the service of its clients, has applied the method to a wide variety of geological provinces in such areas as North and South America and Europe.

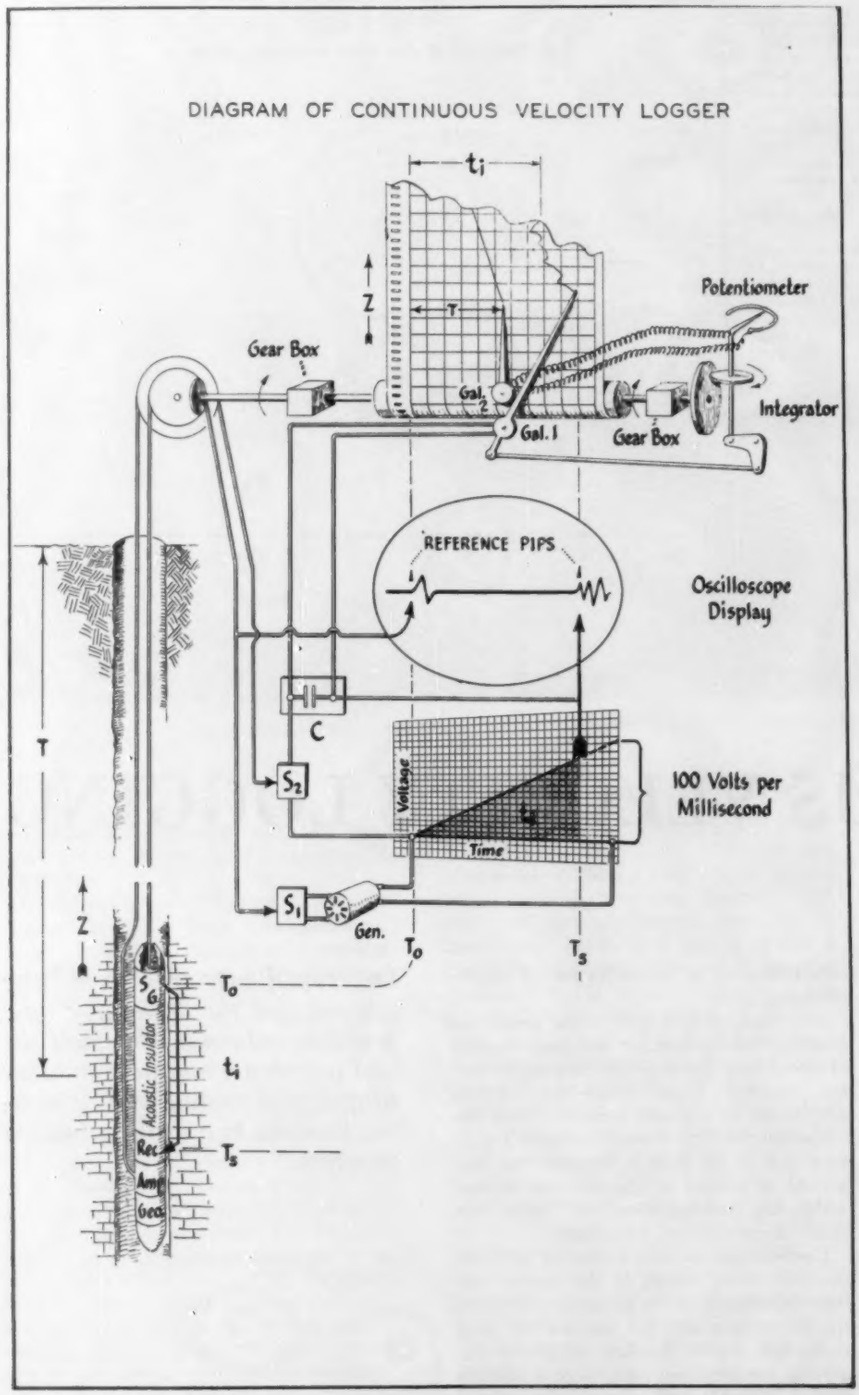
Accomplished by running a tubular-shaped device on a conventional well-logging cable, the instrument is lowered to the bottom of the hole and returned to the surface on the logging run. The bore hole tool consists of an ultra-sonic generator which emits pulses at the rate of 20 a second. The generator is separated from the signal receiver by about six feet of acoustical insulation.

The receiver unit detects the pulse and provides information for the measurement of travel-time between the transmitter and the receiver. These times-versus-depths are plotted by a special recorder. Since the formation velocity is nearly always higher than that of the fluid in the hole, the first arrival of energy at the receiver is that which has traveled along the "least time path" of the sidewall formations.

Continuously as it is pulled up the hole, the instrument relays to the surface the interval velocity of the formations between the transmitter and the receiver for their respective depths. Surface equipment receiving the impulses consists of a velocity recording panel and also a conventional seismic recording unit for normal well-shooting. An oscilloscope is used for continuous check of logging accuracy.

In the early application of the reflection seismic method, velocity was quickly recognized. Steps were taken to provide a technique to capture it. Lowering a seismic geophone into a deep bore hole, crews fired seismic shots near the surface. From this set-up, the direct travel-time between the explosion and the geophone was obtained. After a number of geophone locations were occupied from bottom to top, their timings

Developed primarily to aid the seismologist the technique now is widely valued by the geologist and petroleum engineer in identifying fluid content and estimating porosity in a well evaluation program.



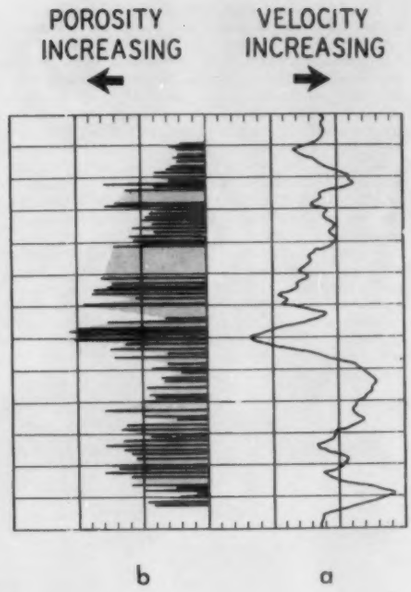
Theory of operation: The logging device consists of an acoustic signal-generator SG *which emits pulses that travel through the formation sidewalls to receiver* Rec.

At the signal-pulse instant, switch S_1 *closes, starting sawtooth generator* Gen *which develops a voltage proportional to time.*

When the acoustical signal arrives at Rec, *switch* S_2 *is closed discharging the generator voltage, as of that instant, into condenser* C. *This voltage is impressed on a galvanometer* GAL.1, *whose pointer traces the value of* t_i *on the log at the indicated depth.*

The time-instant of the signal and its arrival-time as Rec *are displayed on an oscilloscope.*

The integrator provides the over-all travel-time T *for the interval logged by continuous integration of the* t_i *curve.*



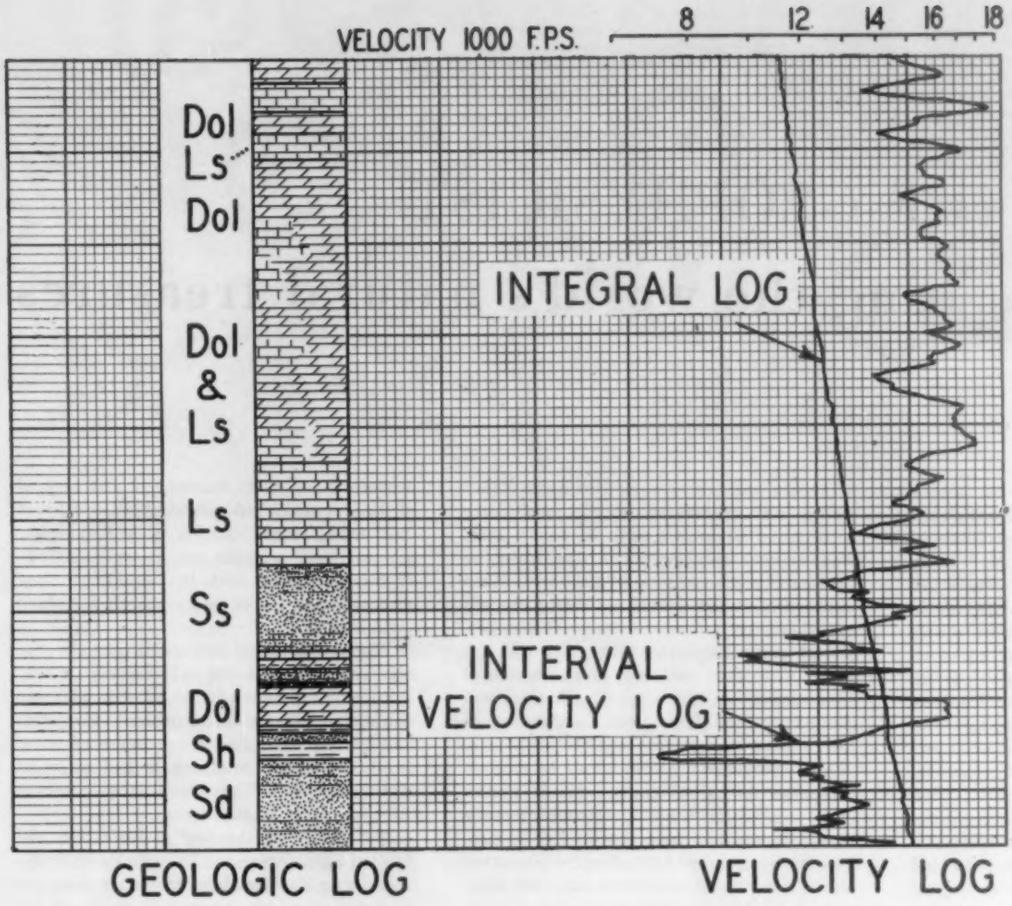
Correlation with porosity of limestone formations. The results of an experimental investigation by Magnolia Petroleum Co. in an effort to correlate interval velocity with porosity in limestone is demonstrated. The envelope of the porosity log shows marked similarity to the interval velocity curve. Porosity samples were taken and porosity values obtained as indicated by the horizontal bars. Lack of sample is indicated by absence of a bar.

provide the data to construct the travel-time depth curve. Although a substantial number of well-shooting velocity profiles have been obtained through the years in the oil country, the potential of the velocity principle was veiled from the lack of mere detail.

These details as now revealed by the new technique point out clearly the conditions believed necessary for the origination of reflection. The significant velocity changes responsible for reflections were not clearly defined by conventional well-shooting, even with closely spaced geophone positions.

Results from CVL are conclusive. The continuous logging introduced another approach to examining a bore hole. Electrical resistance, self potential and radio-active propensities of rocks are more intangible than "soundness" of the rocks as indicated by velocity logging.

Positive differentiation between gas, oil or water and the certain prediction of the porosity of sands cannot be achieved by any single logging technique. For instance,



A section of a stratigraphic log and the corresponding velocity and integral logs. The integral log is made by summing-up the interval velocities for the distance logged. It provides the over-all velocity curve needed for seismic time-depth conversions. A geophone attached to the logging tool permits surface shooting to check the integral log curve.

the neutron log does not differentiate between a gas and low porosity sand or between an oil and water sand. Evidence developed in the laboratory now clearly suggests that adding velocity to the resistance and neutron logs should achieve a combination most effective for evaluating the oil and gas possibilities of the formations penetrated by the drill. See Figure 1.

CVL correlates lithological information as well as providing more dependable differentiation.

Idealized logs of Figure 1, taken from material prepared by Warren G. Hicks of Magnolia, are based on his study of numerous logs obtained in the Miocene belt of the Texas and the Louisiana Gulf Coast.

Velocity and resistivity correlations which normally are similar, are now shown in reverse for the logs of tests completed in this area. Here the water sands commonly show less resistivity than the adjacent shales. Yet, as expected, the water sand velocities are higher than shale velocities. When the velocity in sand is lower than in the adjacent shales, and the resistivity is higher, according to Mr. Hicks, this is exactly the condition sought. He states the analysis of these indicates hydrocarbon saturation is almost certain to exist. High resistivity and low velocity correlation in the Gulf Coast area has established a pattern. Other lithological data is continually being proven as CVL is utilized in other areas. With the CVL method, each test provides vital information to the client as well as the industry itself through successful application of the method.

Lithological alterations also are associated with age relationships which velocity logging confirms. Compaction due to overburden increases elasticity and density and thus, velocity with depth in the geologic section. This observation was noted first in the earliest seismic refraction surveys.

CVL was first developed with needs of the seismologist in mind, but is now in great demand by the geologist. The velocity log, in combination with resistivity and neutron logs, makes significant contributions to this group. They permit a more dependable identification of the fluid content in rocks as well as porosity of the formations.

Therefore, CVL is showing that it contributes to more effective seismic interpretation by providing vitally needed velocity data and in addition is a valuable parameter for direct bore hole examination.

This dual role is best achieved if there is close coordination between the geologist and the geophysicist and also the petroleum engineer. A balanced oil well evaluation program is strengthened by correlated and reliable data stemming from a mutually agreed method.

In terms of economy, CVL permits a more revealing interpretation of the bore hole with its detailed data on the velocity parameter within the geologic section. Time, material and labor are consequently saved by the application of continuous logging in addition to revealing a more complete picture of the oil finding and producing problem.

ROLE OF THE GEOPHYSICIST
in locating the world's natural treasures

By John W. Fludé

THE use of science—concentrated in several of its branches—in locating the world's natural treasurers, is of quite recent origin, and is best demonstrated by the petroleum industry. The basic science, of course, is geology closely followed by paleontology. Petroleum is found under certain geological conditions, in rocks of certain age ranges which were deposited and perhaps altered under certain environmental situations. The geologist, often with the help of the paleontologist, must select the areas of the world wherein these conditions seem to exist.

Further, in many of the selected areas the geological conditions existing at a considerable depth may be accurately predicted by the geologist. In others, the geological conditions may be less accurately predicted, and in many relatively flat, alluvial plain areas subsurface conditions are obscure or entirely unpredictable. For the purpose of illustration, I shall give a brief history of one of the world's most prolific petroleum areas which was in the "obscure or entirely unpredictable" category.

In the Gulf Coast of Texas and Louisiana there were known to exist salt domes—enormous masses of salt. The first, Avery Island, was discovered in 1791 and there were some 16 known salt domes in 1900. One, the Sulfur Dome was drilled in in the 1860's and salt was found at 1,480 feet. More interesting, sulfur was found above the salt and there were shows of both oil and gas. So oil men suspected that oil might be found associated with salt domes which of course, was proved when the Lucas well came in at Spindletop Dome in January of 1901.

This discovery precipitated a drilling campaign on other known domes and a wide search for other domes. Previously known domes had been discovered by surface expression; a hill of some elevation above them in an otherwise very flat alluvial plain. The geologists did their work well, discovering 12 new domes in 1901, two in 1902 and with the three discovered in 1903 had more than doubled the known domes.

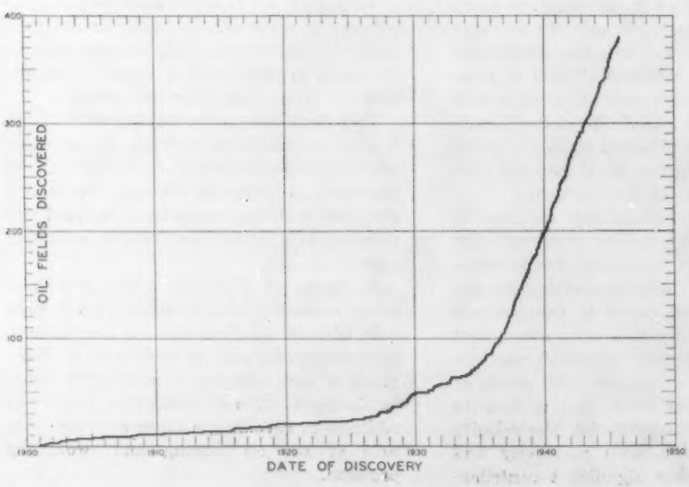
By that time such clues as surface expression, gas or oil seeps, or paraffin dirt had been so nearly exhausted that only 10 domes were discovered from 1904 to 1918, and then there was a skip of six years when no new domes were discovered. The deepest drilled dome found salt at about 3,700 feet but the general opinion was that other domes must exist deeper, as well as shallower, than 3,700 feet. It would be a slow and expensive process to search for them with a drill.

With beds being bent or broken by the upward thrust of the salt masses, it was natural to expect faults of considerable length and throw to be present. However, the surface beds had been deposited after any such faulting and surface geology could not detect them. They were as well hidden as were most of the domes.

By 1924, the known reserves in the United States were not keeping up with the increasing demand for petroleum products and the stage was very well prepared for the introduction of some revolutionary exploration methods—the refraction seismograph, the torsion balance, and the magnetometer. Real exploration field work began in 1925, but the volume of work plus the lag between discovery and drilling did not disclose the potentiality of the new tools until about 1927. Between 1924 and 1932—eight years of time—58 domes were discovered by geophysical methods—more than had been discovered during the previous 130 years.

The accompanying graph shows Gulf Coast oil fields discovered by drilling, by months and years, from Spindletop, 1901 to 1946. This graph indicates that from 1901 to 1926, the discovery rate was rather consistant at 0.75 structure per year. With the advent of the refraction seismograph and the torsion balance the discovery rate rose to 5.4 structures per year. Actually, and to be fairer, it might be shown that these methods averaged a discovery rate of about seven structures per year up to 1930 and that a decline to about four per year followed until 1933, at which date a spectacular rise began when the reflection seismograph replaced the refraction seismograph and the gravity meter replaced the torsion balance.

By 1930, the refraction seismograph had discovered just about all of the domes with salt at 5,000 feet depth or less. In attempting to predict domes of deeper depths, there



Oil discoveries on the Gulf Coast from Spindletop through 1946, showing how the discovery rate has climbed since introduction of the gravity meter and the reflection seismograph in the early 1930's.

John W. Flude, vice president of International Geophysical Explorations, Inc., began his geophysical career with Geophysical Research Corp. in 1927 following his graduation from the University of Illinois. In 1931 he helped organize Independent Exploration Co. and in 1953 the Offshore Exploration Group.

In recent years his interests have centered in international exploration work beginning with the organization of his present company in 1955. Mr. Flude is the holder of numerous patents in the marine geophysical exploration field.

were a number of failures and the method was so discredited that very few crews remained in the field during or after 1930.

Though the torsion balance, and later, the gravity meter have been credited with many original discoveries, gravity methods find their greatest use in reconnaissance work, using the seismograph for detail. At the time of the decline of the refraction seismograph, the torsion balance was finding evidence of deep seated domes, but due to the state of the art, the exact location of these anomalies was in doubt and a number of drilling failures were recorded.

The reflection sesimograph was introduced in the Gulf Coast in 1930, but was not immediately successful. Oddly, its lack of success was due to too much reflected energy and the fact that the reflections indicated or obtained at one point could not be correlated with those taken at other nearby points. However, in little more than a year's time the "dip method" of computing the data had been introduced and a spectacular discovery rate began which soon steadied to an average figure of 30.6 new fields per year, as the graph indicates.

The gravity meter was introduced in 1932 and replaced torsion balances as fast as meters were assembled. The gravity meter obtained readings at various points. After applying various corrections, the resulting figures could be plotted on a map and contours could be drawn, something that could not be done easily with torsion balance data. The gravity meter could be set up and read much quicker than the torsion balance.

Schlumberger well logging was introduced in the early 1930's and became an important geophysical tool. Today hardly a well is drilled without running a Schlumberger, or similar well log.

Several other geophysical methods have been tried in the Gulf Coast, but the fact that they are not in use today indicates that they were not as successful at finding oil as the methods discussed above.

Exploration for petroleum by geophysical means has been successfully carried out in all parts of the world which have had the attention of petroleum producers. On the other hand, there are areas, fortunately relatively small in extent, where the geophysical methods so successful in most cases, show poor, or no results. Some types of petroleum traps are almost impossible to detect by geophysical means. A case in point is the huge East Texas field in which the production is found in a sand which pinches out against the enormous Sabine Uplift.

Of course, any geophysical method attempts to measure, usually at some considerable distance, some physical quality possessed by the material being sought or by some other material with which the sought material is generally, often, or sometimes associated. If you are seeking something that has a distinctive weight and mass or is slightly or somewhat magnetic; if sound passes through it with a distinctive velocity or if it is peculiarly capable or incapable of conducting electricity, one or more geophysical methods might help you in your search. Geophysics might measure the thickness and extent of overburden and the thickness and extent of some (at least) types of ore deposits.

If it is necessary to see, feel, taste or smell a material to be sure of identification, you are in the realm of the geologist. But if you can find some physical distinction which sets the material apart from others and which can be measured even approximately by some scientific instrument and at a distance, geophysics will help you. You might ultimately require an instrument which is as yet undeveloped and the experimental costs would raise the initial expense of the endeavor.

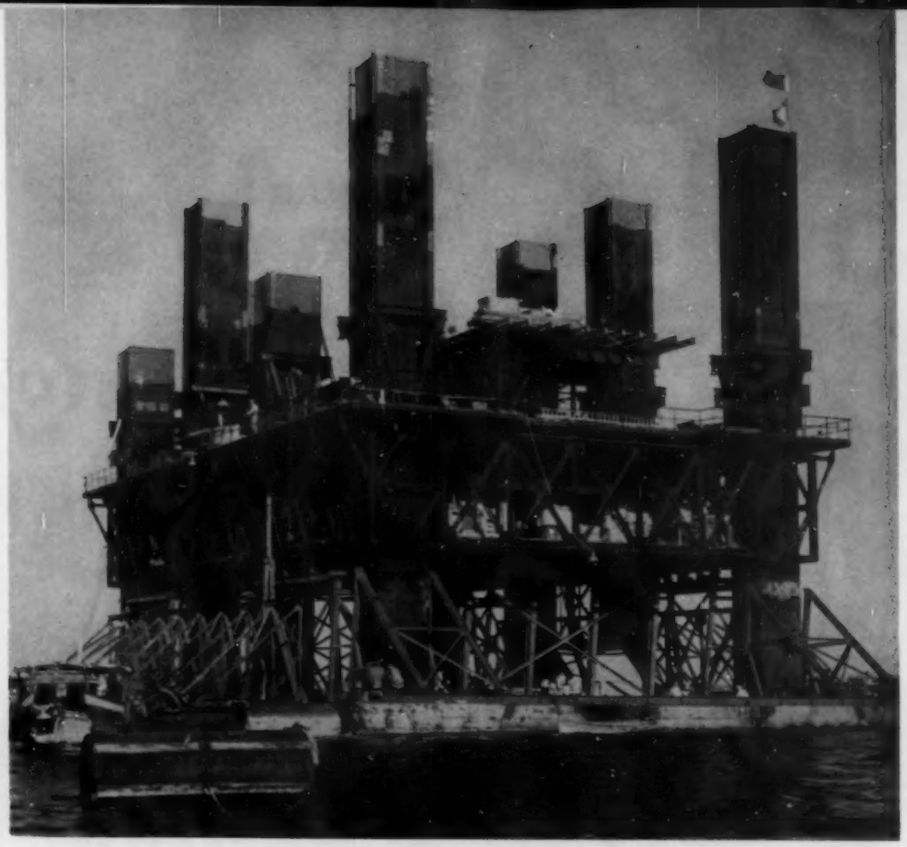
In describing the part geophysics has played in the petroleum development of the Gulf Coast, I have made it appear that the geophysical problems were quite simple, and actually I think they were. Still, there were and are problems, and a constant search for their answers goes on. The gravity meter bears little resemblance to the torsion balance. The reflection seismograph is entirely different from the refraction seismograph. From the beginning there has been a constant improvement in instrumentation. Obviously, experience in interpretation would lead to better interpretation of data and this has been borne out.

Bear in mind the pattern of discoveries. First, we found it easy to locate shallow salt domes. Next, we covered the same areas looking for deeper structures with considerable uplift, gradually reducing our standards or requirements to the point where a wide spacing in the contours might be recommended. We worked out fault patterns and searched for closure against these faults. We now attempt to work out very complicated fault patterns on top of large structures. Whereas in the beginning and for some years discovery was almost 100 percent geophysical, we are now at the point where a discovery can as well be called geological as geophysical. The geologist and geophysicist now work very closely together. The geologist is armed with an enormous amount of well log data and he can predict the possibility of production if a suspected fault is really there or if a point can be found which is structurally a little higher than at some particular well that has been drilled.

It seems quite likely that a similar approach would produce similar results in the search for other natural treasurers. In fact, besides petroleum, it is well known that other geophysical tools, the geiger counter and the scintillometer, have discovered very considerable amounts of uranium ore. In that field the seismograph has been used to predict the extent of an uranium deposit after its existence was confirmed at an outcrop.

The geophysicist has many types of instruments for measuring the physical properties of matter. Individually, or in combination, these instruments might be used in locating other treasures. As was the case in the exploration for petroleum, even useful instruments might require alteration or refinement before they would be capable of accurate or economic exploration success. Experience in the petroleum field has shown that when improvements in instruments, methods or computations were needed, they were forthcoming.

A successful geophysical campaign would require a fairly long-range program and the determination to carry it straight through in spite of possible early set-backs or even failures.



A 1,200 ton movable offshore drilling platform has been set up by Shell off the coast of Qatar. The picture at right shows the platform in the last stages of construction. It was completed in just over nine months at a total cost of around £5 million or $1.4 million, based on experience received in offshore operations in such areas as Lake Maracaibo and the Gulf of Mexico. (Photo courtesy of Shell)

exploration in the MIDDLE EAST

By E. Lawson Lomax

A new estimate doubled Middle East reserves but exploration continues high, including offshore work.

EXPLORATION in the Middle East during 1955 and 1956 was highlighted by the discovery of a good producing well in Kuwait and the opening of the offshore areas of Kuwait.

Iraq—Development of the Jambur and Bai Hassan fields is continuing. A 20-inch pipe line has been laid down from Jambur connecting with the main pipe line system at K1 pump house, a distance of 36 miles. This field is now in production at about 10,000 b/d. The pipe line was filled in December, 1955. Production has not yet started from the Bai Hassan field. Exploration activities at Kor Mor have been temporarily suspended. Six wells were drilled during the year, four of which were producers.

The well drilled by Mosul Petroleum Co. at Atsham has been abandoned as a dry hole. Exploration wells are being drilled at Sasan, near Tel Afar, at Alan and Jabul Makul, while two geophysical parties are working in other sections of the territory covered by the Mosul concession. The above dry hole was the only well completed during the year. A good structure was mapped 40 miles west of Zubair, which has not yet been drilled.

Geophysical surveys by Basrah Petroleum Co. are being carried out between Rumaila and Busaiya, as well as in the western districts of the territory and the south of Rumaila. Other parties, including two seismic parties, are out between the Tigris and Euphrates. Eight wells were drilled during the year, all producers.

Qatar—Nine wells were drilled during the year by Qatar Petroleum Co., six of them being producers. In recent years a large amount of geological examination and exploratory drilling has been carried out along the Trucial Coast, in the Sheikdoms of Dubai and Abu Dhabi and the Sultanates of Muscat and Oman.

Shell Petroleum Co. has acquired a concession from the Ruler of Qatar, covering an offshore area of the Persian Gulf. A platform, the design of which was based on Shell's drilling in the Lake of Maracaibo, in the Gulf of Mexico and in the China Sea

off British Borneo, was fitted with an Ideal 50 rig, and drilling was begun early in 1955. The first well was completed as a dry hole at a depth of 6,706 feet. The platform was moved to a location 45 miles offshore, northeast of Doha, where the depth of water is 45 feet. A new 12,000-foot rig, an Ideal 100, has been installed on the platform. Expenditure by Shell on this project to date is about $14 million.

Trucial Coast—Shortly after the end of the war, exploratory drilling by Iraq Petroleum Co. began along the Trucial Coast, based on seismic work. The first well was drilled at Ras Sadr in Abu Dhabi, and was abandoned as a dry hole at about 13,000 feet. The next well was sunk at Jebel Ali in Dubai and also was abandoned as a dry hole at 12,353 feet.

A third well was drilled at Murban in Abu Dhabi and a showing of light crude was encountered. This well also was closed later, owing to technical reasons and a heavy flow of toxic gas which killed one of the crew. A fourth well was drilled at Gezira in Abu Dhabi to below 12,000 feet with no shows reported. A seismic party is working near Sila, on the Trucial Coast.

Beyond the three-mile offshore limit from Abu Dhabi, a concession covering about 12,000 square miles is held by Abu Dhabi Marine Areas Ltd., owned by D'Arcy Exploration Co. and the Companie Francaise des Petroles. The company employed Captain Cousteau and his vessel the "Calypso" to make a survey of the floors of the seas in this area in 1954. This preliminary survey is now being followed by a soil investigation of the sea bed, which is being carried out for the company by the contracting firm of George Wimpey & Co. Ltd.

The 1,200-ton passenger-cargo ship M.V. "Astrid Sven" has been equipped for survey work with heavy mooring winches and drilling equipment, as well as specialized meteorological and hydrographical equipment, and has living accommodations for the working party of about 30 men, including geologists, engineers, drillers, etc. The tug "Dexterous" will be used for locating and buoying the chosen sites. The vessels are operating about 50 miles offshore and carry stores and equipment sufficient for several months of work.

To the south and southeast of the Sheikdoms of the Trucial Coast lies the Rub 'al-Khali or Empty Land, which covers an area roughly 1,000 by 500 kilometers with undefined boundaries. The northeast portion adjoins the Sultanate of Muscat and Oman, the greater portion of which is shut off from the Gulf of Oman by the Oman Mountain range, which rises in places to 10,000 feet. South of this range and in the interior of the Sultanate, lies the geologically most promising territory where, at Jebel Fahud, an exploration well was recently spudded in. Jebel Fahud lies approximately at the junction of the line 55 longitude and line 22 latitude east.

Access to this location was extremely difficult. The geological and geophysical party travelled by land over 200 miles with its equipment from the small port of Ras Duqm on the Arabian Sea coast. A certain portion of the drilling equipment was landed at Ras Duqm and taken overland in special trucks, but 1,000 tons and all the personnel have been flown over from Qatar, which has good port facilities at Umm Said, to landing strips made at Jebel Fahud, 390 miles as the crow flies, and at Ibri close by. Drilling was begun in early 1956. In addition to the well being drilled at Fahud a field party is at work north of this location.

Exploration parties have entered the Rub 'al-Khali from the Saudi Arabian side on behalf of Aramco, but it is not known how near to Jebel Fahud they are working.

Petroleum Concessions Ltd. has a survey party working on its concession in Hadramant.

Kuwait—There has been considerable activity in the northern area of the country. A good well has been struck at Raudhatain about 15 to 20 miles south of the northern border and a second well is now being drilled in the same location. No information has yet been released regarding the depth or production capacity of this well nor of the strata in which production has been found, but it is understood that the company is quite optimistic about this new strike. The well is reported unofficially to have been drilled ahead to 10,310 feet and to have been completed as a large producer from about 1,200 feet of pay in three formations.

An announcement was made by the representative of the Sheikh of Kuwait during early 1956 that the offshore areas of Kuwait and those offshore areas of the Kuwait-Saudi Arab Neutral Zone which belong to Kuwait would be opened for concession. Draft concessions are being prepared. The present Kuwait Oil Company's concession and that of American Independent Oil Co. (AMINOIL) over Kuwait's share of the Neutral Zone do not include the offshore right.

Underwater exploration in the Persian Gulf involves risk from sharks. Shown are two divers descending in a shark-proof cage in which they can take shelter if necessary. (British Petroleum Co. photo)

Estimates Middle East reserves at 230 BILLION BARRELS

Proved reserves of liquid hydrocarbons in the Middle East have been estimated at 230 billion barrels in a report to the United States Congress. The estimate was for the Joint Congressional Committee on Atomic Energy and was prepared by Wallace E. Pratt, who recently retired as vice president of the Standard Oil Co. (N.J.).

Mr. Pratt consulted with well informed and experienced operators in the Middle East before making up his new estimate. His figures contemplate a recovery of only 40% of the oil in place and on this basis he feels that the figures are conservative.

Free world estimates in billions of barrels by areas as of Dec. 31, 1954 are as follows:

	Liquid Hydrocarbons
United States	35
Other N. America	7
South America	27
Western Hemisphere	69
Western Europe	1
Middle East	230
Oceania & Far East	6
Eastern Hemisphere	237
World	306

In the case of natural gas, Mr. Pratt placed known world reserves at 344 trillion cubic feet of which 275 trillion is in the Western Hemisphere with 212 in the United States, 20 elsewhere in North America and 43 trillion in South America. In the Eastern Hemisphere the Middle East has 62 trillion cubic feet, Europe three and the Far East four trillion cubic feet.

Ultimate recoverable free world reserves of liquid hydrocarbons were estimated at 900 billion barrels of which 170 billion are in the U.S. and 730 billion elsewhere. Ultimate gas reserves were placed at 3,850 trillion cubic feet with 850 trillion in the U.S. and 3,000 trillion elsewhere.

Mr. Pratt points out in his summary that the attitude of the petroleum industry toward atomic energy is conditioned by its estimates of future oil supplies and future energy demands. The industry looks forward to a continued expansion of oil consumption over the next two decades and is serenely confident that it will be able to find enough oil to supply this demand.

Between the Drake well and 1951 the oil industry discovered 1.6 barrels of oil for every barrel produced. During the past 18 years the ratio has been 1.5:1. Proved reserves have been maintained at 12 to 14 times annual production despite the rapid rate of rise in demand.

Current estimates are that demand in the United States will increase at the annual rate of 2.4% in the next 20 years. Demand thus would be 77 billion barrels in the two decades. Assuming that the industry will import 10% of its requirements, it would be necessary to find 69 billion barrels of new oil.

Mr. Pratt reported that various observers have estimated that discoveries in the next 20 years in the United States would range between 75 and 100 billion barrels. Most oil men reject the highest figure, but Mr. Pratt points out that all previous long range estimates have been much too low and that we may well expect to find 100 billion barrels of new oil.

Mr. Pratt wrote that, "A significant bit of evidence that a great deal of oil remains to be found in the United States, despite the tremendous volume that has already been produced, is the phenomenal discovery rate the industry has set up in its exploration of the continental shelf off the coasts of Texas and Louisiana. Never before, I venture to say, has the industry scored so high a success ratio in its exploration of a totally new petroleum province in the country. Never before have the first 116 wildcat wells drilled in wholly virgin territory in the United States, yielded as many as 50 successful completions; a success ratio of 44%. We are accustomed to a success ratio of about 10% among our wildcat tests. But here in our latest effort, under unusually difficult conditions, our success ratio is more than four times as high. This is an amazing record. Notwithstanding our long and thorough search for oil in the United States our newest petroleum province is the most prolific we have yet found."

An important factor in meeting demand will be improved techniques of oil recovery. Present known reserves are based on a 32% recovery factor which means that 185 billion barrels of oil remains in the earth until methods are improved.

Mr. Pratt also calls attention to the shale oil resources in the United States and tar sands of Canada. Colorado shale can supply economically 100 billion barrels of oil. The Athabasca tar sands have an oil content of 300 billion barrels of which five billion barrels may be recovered economically. Synthetic oil from coal can be vastly expanded as can both shale and tar sand oil at higher cost.

The complete report presented by Robert McKinney occupies some 750 printed pages of which Mr. Pratt's study comprises 17 pages.

Mr. Pratt stated in his section that the petroleum industry believes that atomic energy should be vigorously developed, but by private enterprise. The government should recognize, he said, that petroleum and competing energy resources constitute the base on which the dynamic character of our economy chiefly rests.

The McKinney report found that oil and gas have nothing to fear from competition from atomic energy during the next few decades. In fact, most oil men "welcome" the coming of a new source of energy. Actually, the report said, atomic energy could take over some "profit barren" fuel oil markets now served by oil. An oil would have more crude oil to crack into lighter fractions, from more profit. In all this, Mr. Pratt agreed.

The McKinney report is the nation's major effort recently to gauge when atomic power will be coming along, and where. On this, the report found:

(1) There is "promise" that atomic power will be a major source of electric power generation. Much research is needed, and much money should be spent, by government if not private industry, to hasten the day.

(2) Ship propulsion by atomic power is technically possible, but too costly. The first type to use atomic power commercially should be an oil tanker.

(3) The atomic-powered airplane is not yet possible technically, and far off on a cost basis. If it comes into commercial use, it will be as a byproduct of military testing and development.

(4) Locomotive propulsion by atomic power is probably possible, but offers no economic advantages yet.

(5) The atomic-powered automobile is not even a dream, much less in sight, as it would be too costly, and too dangerous in the event of accidents.

The tanker part of the report holds that the cost of a conventional $10 million oil tanker would be approximately doubled by the installation of a nuclear power plant. Yet, the ship would have about the same operating expenses, except for the cost of fuel. Thus, to make this work out on a financial basis, savings in initial cost or elsewhere are needed.

"Atomic propulsion," says the report, "should have the best chance of being competitive in the case of large, high-powered ships which carry heavy bulk cargoes in unlimited supply and spend the maximum amounts of time at sea.

"Ships with these characteristics could utilize the heavy investment in nuclear power plants to the maximum advantage and could employ effectively the space saved by eliminating fuel supplies to increase the cargo payload.

"The Maritime Administration considers oil tankers and bulk ore carriers the best examples of these types of commercial vehicles.

"A modern oil tanker, for example, has a very large cargo payload and spends up to 90% of its life at sea. The fuel oil required by a tanker for a long voyage may amount to as much as 10% of the payload of oil delivered.

"The elimination of this fuel oil requirement by atomic power could be translated directly into an increased payload of oil. This could result in additional revenue for a single 20,000 tons tanker equal to about $1 million a year."

Magnetic Recorders » Acoustic Loggers » Gamma-Gamma Loggers
Time Shifters » Plotters » Filters » Thumpers

NEW TOOLS FOR THE GEOPHYSICIST

THE year 1955 was marked by the commercial introduction of a number of new instruments developed to assist exploration geophysicists in their global search for oil. The year also saw the reactivation of an earlier geophysical method which had been shelved for nearly a quarter of a century.

New methods of storing data gathered in the field for subsequent interpretation at central locations and new aids to interpretation were outstanding developments of the year. An approach was made to automation in storage and interpretation has been termed "Seismation" by one large manufacturer of technical equipment. Studies are in progress seeking methods of applying modern computers to the job of examining seismograph records in the laboratory.

Acoustic velocity logging has been applied to obtain correlation of strata over wide areas and to aid in the interpretation of seismic data.

The Geograph has found greater use during the past year and recently has been used offshore, as well as on land. The Geograph or "thumper" drops a 3-ton weight on the surface of the earth or of water instead of using explosives to generate seismic energy.

Density data for gravity work is being gathered with a newly improved gamma-gamma density logger. Several companies are studying the device intensively in an effort to evaluate its usefulness more accurately.

Most explosive in its rate of increase has been the magnetic recorder for storing seismic records. It is estimated that 20 percent of all seismic crews now in the field are using these recorders.

With the magnetic recorder, seismic data is transferred to discs, tape or other convenient storage material. It can later be played back in the laboratory with the use of various techniques for filtering out unwanted data and concentrating on the specific information required.

Many of the playback units have heads with adjustable time delay capable of preparing seismic records unobtainable with earlier recording equipment. Time shifting permits adjustment on each trace for time delays caused by weathering, normal moveout and elevation. Where trace composition is practiced this may avoid cancellation of reflections and perhaps missing important information in an area of poor reflection. Two types of time shifters have been offered to the industry.

Various filtering methods have been employed in magnetic data processing. Trace multiplication following time shifting has been used to give more signal-to-noise than by trace addition. Trace addition is accomplished by picking up a signal from a drum surrounded by spaced headers with adjustable sensitivities. Weighted outputs of the heads are added.

Improvements have been sought in the methods of presenting seismic data so that the interpreter will visualize subsurface conditions more readily. The Reynolds plotter is one such device. This is an optical system which shifts signals along a time axis to compensate for elevation, weathering and normal moveout. It transforms the time scale to a depth record for suitable presentation as a vertical cross section. As previously mentioned, head shifters are being employed for a similar purpose.

Four types of acoustic velocity loggers have been offered to the industry and are being used increasingly. Originally designed to obtain seismic velocity information conveniently, the loggers now are used more widely for strata correlation. The velocity log may be employed by the geologist to pick a formation top because the record may be even more distinctive than that of the electric log.

The very great volume of new information made available to the geophysicist by velocity logs presents the research worker with a challenging new field of study which may result in great improvements in the techniques of finding oil. He already has a far greater understanding of the origin of reflections in a complex section giving a firm basis for another break through.

Another new technique is one which has been adapted for oil from the mining industry. High frequency seismic recording has been employed in areas of complex structure with close geophone spacing. This has made possible the mapping of steep dips, overthrusting and unconformities at shallow depths. High frequencies also have been used to detail shale bodies surrounded by sand.

For the ninth annual midwestern meeting of the Society of Exploration Geophysicists at Fort Worth to be held March 8 and 9 a number of papers were prepared which deal with improvements in equipment for seismic work. Dr. John P. Woods of The Atlantic Refining Co., Dallas, reported that there have been several near revolutions in the past 30 years and that another appears to be approaching with the introduction of magnetic recordings, computing machines, correlation machines and the generation of seismic waves by weight dropping. Dr. Dayton H. Clewell of Magnolia Petroleum Co., Dallas, agreed that the industry is on the verge of really substantial advances.

Papers were presented by a number of authors suggesting the application of electronic computing machines for data processing and the computation of regional anomaly. G. C. Phillips, L. M. Mott-Smith and W. J. Gundlach of General Geophysical Co., Houston, reported on the application of an analog computer to the design of a compensator for a complete seismic system. Reported result was a phase characteristic linear between 12 and 120 cycles per second.

Alternative modes of seismic recording were reported by Frederick S. Kramer and Dr. Raymond A. Peterson of United Geophysical Corp., Pasadena, Calif. These included moving light spots, variable density and coded flashing methods.

At the request of the editors of WORLD PETROLEUM, various manufacturers of geophysical equipment have supplied the following information on their own particular recent developments:

SEISMATION

The Texas Instruments group of companies have devoted much of their attention during the past year to development of the "Seismation" concept on the theory that the trend to foreign exploration, with the immense size of the unexplored areas, combined with the limited number of trained personnel makes the application of the automatic electronic data gathering and processing techniques imperative.

The TI companies are engaged in research, manufacture, and exploration and hence have been able to accelerate this trend because of their intimate familiarity with geophysics and instrumentation.

Houston Technical Laboratories, one of the TI companies announced commercial

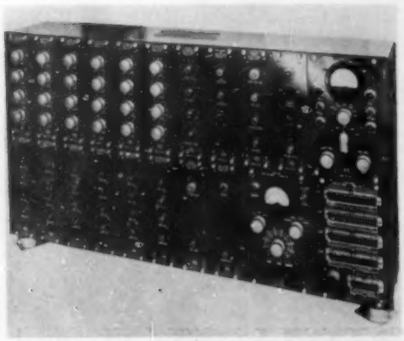


Fig. 1—*The electronics case houses the FM modulators, FM demodulators and all necessary testing equipment for monitoring modulation, power supply voltages and output voltages.*

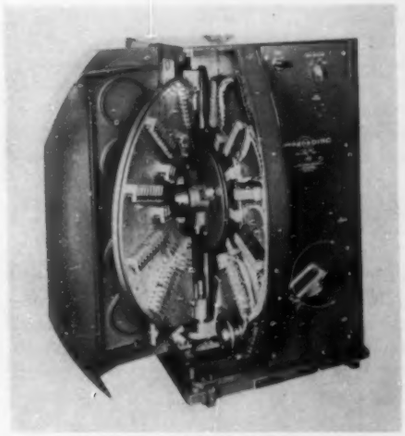
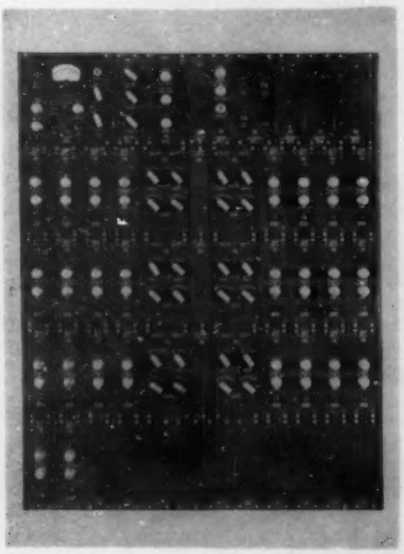


Fig. 2—*Transducer unit, showing the recording heads and pressure plates that hold the magneDISC. Opposite side opens to give access to the timing unit.*

Fig. 3—*7000B "All Purpose" amplifier bank.*



production of its "MagneDISC" magnetic recorder in February, 1955 as a means of storing field data.

The first MagneTIME Delay Unit was shown at the Denver SEG show and is now in field use. It is the next step and resolves normal moveout, weathering, and elevation corrections automatically.

This was followed in December by announcement of the 7000B "All Purpose" seismograph system as another step in "Seismation." With this one integrated system, all available seismic data can be recorded . . . reflection or refraction; low frequency, conventional, or high frequency. The information can be stored "broadband" on the MagneDISC and played back at any future time with any desired filtering, time delay, compositing, or whatever desired.

The succeeding step, the MagneSTACKER, permits the automatic electronic compositing of separate records for securing optimum reflection quality by reinforcing reflections and cancelling noise and ghost. HTL and GSI have launched and are already using this new "Seismation" concept in global exploration for oil. Semi-automatic and automatic electronic data gathering, reduction, and interpretation techniques and instruments cannot help but increase in the view of TI engineers.

Details of new equipment development of HTL are given below:

The MagneDISC has been developed as a convenient method for recording up to 96 data channels on one easy-to-load plastic disc, avoiding playback discontinuities, time consuming loading operation, data limitations, and other restrictions.

Because recording is done in one complete revolution of the disc (5½ seconds), the shot may be fired at any time, thus eliminating recorder starting problems. Discs are changed simply by pushing the "eject" button and slipping a new disc in place. Immediate playback through a recording oscillograph with continuous reproduction of recorded data is another MagneDISC feature.

The disc records can be easily and safely stored for long periods of time.

MagneDISC is particularly useful in any area where a number of shots, using different filter combinations, are normally required to obtain an optimum record. In such an area, MagneDISC makes unnecessary several conventional shots by means of broad band recording with subsequent playback using the necessary filters to get the optimum record. It is especially effective in offshore operations where shots are made at close intervals. It also simplifies seismic survey in swamps.

The MagneDISC system consists of a compact drive unit, with frequency modulators, demodulators and test circuitry in a separate case. Weight of the entire system, including power supply, is 282 pounds, (Fig. 1).

Equipped with magnetic recording heads for 48 seismic channels and 12 auxiliary channels, the standard model can record four 24-trace shots per disc. The recorder can also be supplied with 96 recording heads, plus 19 auxiliary heads, grouped to record six 16-trace shots, two 48-trace shots, or one 96-trace shot. The disc is driven by a fork controlled dc motor to which it is gear coupled. (Fig. 2)

The MagneDISC has a signal-to-noise ratio of 46 db where peak output signal is measured at ¾ of 1 percent distortion and noise is the measured peak value. Frequency response is ±3 db from 10 to 300 cps. Base timing accuracy is ±0.5 millisecond between traces with a timing signal accuracy of 1 part in 10,000. The measured harmonic distortion is ¾ of 1 percent. Recording time is 5 seconds after the time break. Demodulator output is 70 millivolts rms at 2.2K ohms and 3 millivolts at 100 ohms for 0.25 volts input at 250K ohms.

ALL PURPOSE SEISMOGRAPH

A new seismograph system designed for all types of seismic recording—whether high, conventional, or low frequency . . . reflection or refraction—was announced by Houston Technical Laboratories in December, 1955. Called the 7000B, it offers linear recording over the wide frequency range of from 3 to 500 cps. (Fig. 3)

The new system incorporates the features of three field-proven systems, will function with magnetic recording, and yet weighs no more than a standard seismograph system. By a simple switching operation, the operator can record in any one of the following three frequency ranges:

Wide Band—Magnetic & VLF (3 to 500 cps)—Its wide frequency response was designed for data storage through magnetic recording. Playback at selected settings allow detailed examination of the complete seismic spectrum. Very Low Frequency linear recording down to three cps and high sensitivity ideally suit the 7000B to determining sedimentary thickness in large basins. All refraction technique requirements can be satisfied with the 7000B while using relatively small charges.

Medium Range—Conventional (15 to 500 cps)—A wide variety of filter slopes and cut-off positions are available to the operator to select the optimum band-pass response in the 7000B for reflection operation and to frequency-analyze the broad band record on magnetic playback. The two-loop automatic gain control has a steady state characteristic of less than 25 percent output variation over a 120 db range plus an operation range of 100 db with less than 1 percent distortion to assure recording fidelity of the highest order.

High Frequency—HR (45 to 500 cps)—High Resolution, high frequency reflection recording provides much valuable new information to the geophysicist, particularly where increased resolution or shallow data are required. Filter cut-off positions and slopes can be selected in the 7000B to permit HR recording when the technique is desired.

Three AGC compression and expansion rates are available. The Fast rate gives

definition and resolution of near surface and close arriving events. Either the Slow AGC compression and expansion rate or a Program Gain Control can be used to obtain full advantage of available dynamic range in the magnetic recorder.

HTL's new RS-8U Recording Oscillograph was designed especially to operate with the 7000B. It has instantaneous paper speed control and a three-position select switch on the front panel for refraction (6.6 in/sec.), conventional (13 in/sec.) and high resolution recording (32 in/sec.). Lamp intensities automatically change with speed selections. Fifty 500 cps galvanometers are used.

The new HTL S-39 (13 to 30 cps) DualDAMP reflection seismometer and the S-36U (2 cps) refraction seismometer are recommended for use with the 7000B.

MINIATURE SEISMOMETER

Another recent HTL announcement was the DualDAMP miniature seismometer weighing less than a pound and with a purchase price of $10 in the United States, Mexico and Canada ($11 in all other countries). The S-39 DualDAMP is a velocity type seismometer especially designed for multiple array use in land exploration.

The S-39 has been named the DualDAMP because it employs both electromagnetic and fluid (Dow Corning Type 200) damping. The seismometer has undetectable spurious response and high lateral stability up to 500 cps, and it has been tested from —60° F to 150° F with negligible change in damping. This feature suits the S-39 to high frequency, high resolution operations.

It is 1⅞ inches high, 1½ inches in diameter and weighs only 11 ounces. The S-39 DualDAMP seismometer has a brass base cap and stainless steel case with a solder seal assuring complete protection of the internal element under the most rugged operational conditions. (Fig. 4)

A special feature minimizing wind noise pick-up is the locating of the takeout connection at the bottom of the S-39. The take-out normally supplied is 18-inch, 400 pound test, wire rope lay cable with a molded reinforcement. Units may also be ordered with a two-hole cap for through-cable connection. Either spike or flat base attachments may be specified at no change in price.

NEW NAVIGATION INSTRUMENT

A navigation instrument called the Dead Reckoning Tracer (DRT) developed by Servo Corp. of America, New Hyde Park, N. Y. for continental air defense has been proposed for exploration of offshore oil lands. Designed originally for the Lockheed Super Constellation-type aircraft, the Navy's WV-2 and the Air Force's RC-121, this instrument gives a continuous indication and permanent record of navigation course and exact geographic position on any standard Mercator map.

The DRT includes an automatic plotting board (Fig. 5), a computer and control amplifier. It is small enough to be installed aboard a shooting-recording ship or helicopter and supply accurate answers to the two big questions posed in surveying operations: What is the exact position of the ship? What is the exact position of the exploding charges relative to the ship? These questions are answered in terms of precise, geographic position on the Mercator map. No further calculations are required; returning crews can accurately locate specific spots at which buoys were dropped and favorable recordings were made. It may be employed to prepare a permanent record of the course flown on aerial reconnaissance flights.

Here is how the DRT works. The computer derives synchro voltages automatically from the ship's compass headings and speed. It converts this reading into both dial readings of latitude and longitude and rectangular coordinate signals to drive the plotting board to proper chart positions. Latitude and longitude are read directly in degrees and minutes on counter-type indicators on the computer panel. This information is also available at remote stations on the ship. The computer can be adjusted to permit the use of any standard Mercator chart ranging from ½ to 70 nautical miles per inch. The instrument is designed to operate from 75° North Latitude to 75° South Latitude, an area which represents 98 percent of the earth's surface.

The plotting board, approximately 44 x 36 x 11 inches weighing 72.7 pounds, plots a pencil line on the Mercator chart which is clamped beneath the plotting mechanism. As the pencil mechanism moves across the map, it projects a lighted cross on a transparent window which is covered by a detachable feed roll of tracing paper. At the instant an explosive charge is dropped over the side of the ship, a mark can be made automatically on the Mercator chart by toggling a switch, or manually on the tracing paper at the point of the lighted cross. These notations provide a precise positioning of buoy drops, within an accuracy of 1/32-inch.

MAGNETIC RECORDING-REPRODUCING-ANALYSIS SYSTEM

The Technical Instrument Company of Houston, and the Clevite Brush Development Company of Cleveland, have combined to design a system for magnetic recording and monitoring in the field, the preparation of corrected records in the field station and the playing back of these records through filter and mixer analyzers to provide completely corrected oscillograph records with optimum filtering and with mixing, integrating, compositing and stacking as desired in the analyzing process.

The total magnetic recording-reproducing-analyzing system consists of the following major equipment:

Field Magnetic Recorder (*Fig. 6*)—including amplifier-modulators, magnetic drum recorder, automatic visual chart monitor playback and associated power supply and timing circuit;

Fig. 4—*S-39 DualDamp seismometer.*

Fig. 5—*Plotting board used in conjunction with dead reckoning tracer for aerial or marine positioning.*

Fig. 6—*Magnetic recorder simultaneously records 28 signals on magnetic tape.*

Fig. 9—*Field station analyzer works directly from output of reproducer. Broad band seismic information is filtered and mixed as determined by operator and fed directly into conventional photographic oscillograph.*

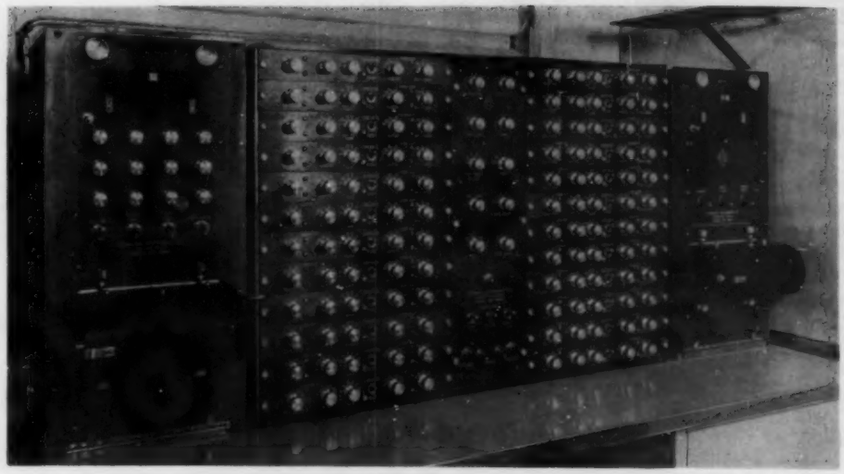
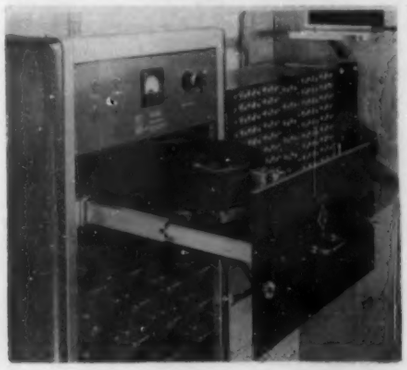


Fig. 7—*Transfer drum automatically scans field tape channel by channel and automatically inserts time corrections for weathering and elevation in accordance with individual settings for each channel.*

Fig. 8—*Reproducer supplies replica of original or corrected electrical signal which can be filtered or mixed and fed into a conventional photographic oscillograph or such special equipment as desired.*



Transfer Drum-Function Generator (*Fig. 7*)—for insertion of weathering, elevation, normal moveout and velocity corrections in the laboratory. This unit may or may not contain one channel of filtering for doing the filtering during the transfer process;

Reproducer (*Fig. 8*)—plays back all 28 channels of the corrected record simultaneously into the final record oscillograph;

Analyzer (*Fig. 9*)—includes 24 plug-in variable filter units to permit a wide range of filtering of the record from the reproducer prior to its going into the final record oscillograph. This analyzer also incorporates a wide range of mixing possibilities, used in mixing, integrating, compositing or stacking records;

Final Record Oscillograph (*Fig. 10*)—a number of models of final record oscillographs with paper widths from 6 to 10 inches and containing from 25 to 50 galvanometers complete with synchronized timing system are available depending upon analyzing and final recording requirements.

The field unit can be mounted in a truck, in a boat, or other similar conveyance. The field station analyzing equipment can be housed in an office or in the home laboratory, or in a trailer to service several crews in the field.

The FM system of modulation was chosen as the proper combination of simplicity in equipment with providing the type of record that can be reproduced and analyzed and reworked a number of times with minimum deterioration of signal.

The transfer system has been incorporated both into the field unit to provide a monitor record for the evaluation of the record in the field, and also in the laboratory transfer drum-function generator system for incorporation of the various elevation, weathering, normal moveout and velocity corrections. The monitor system in the field allows the observer to check the complete workings of his equipment, including the tape itself, to be sure he has a good record. Filtering controls have been placed in the monitor playback equipment so that the observer can filter the signals as he would with conventional photographic type signals for ready comparison and evaluation.

The transfer process also enables the insertion of the various corrections, etc., using solid multichannel heads. The heads used in the system are the Brush BK-1328, magnetic recording heads designed to lay down the 28-channel information onto tape only 2¼ inch in width, to assure timing accuracy, and minimize any effect of any tape distortion.

BRITISH MADE DETECTOR

Seismic Instruments Ltd., Cambridge, England, is manufacturing seismic detectors and ER-62 recording oscillograph cameras at its Granta works for use in sterling territory. Manufacture is under license from Electro-Tech International, Houston. (Fig. 11)

NEW OFFSHORE GEOPHONE

A new pressure sensitive geophone designated the EVP-1 has been developed by Electro-Technical Labs, Inc., Houston, to be used in offshore seismic exploration operations. (Fig. 12) This geophone is of simple and rugged design and has universal application in any water covered area. Advantages claimed for this application are that it is smaller in size, lower in cost, needs no orientation, can be attached directly to floating or bottom cables in deep or shallow water exploration. The physical appearance is quite similar to the maker's well known EVS-2 velocity type geophone with the exception of a water proof diaphragm being

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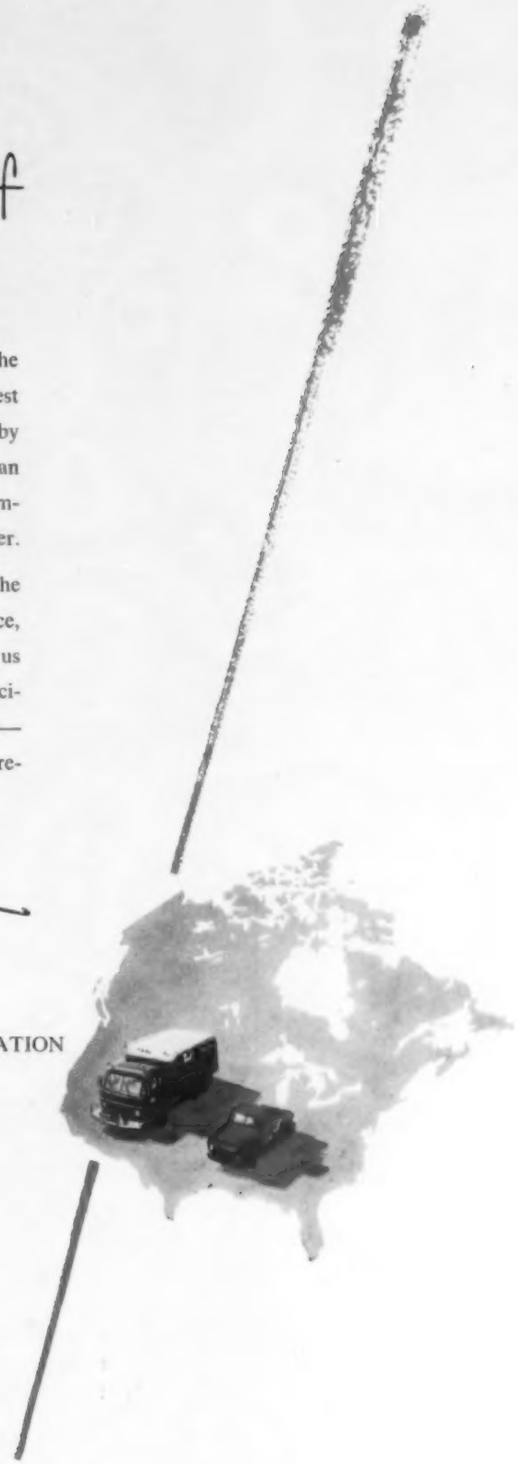

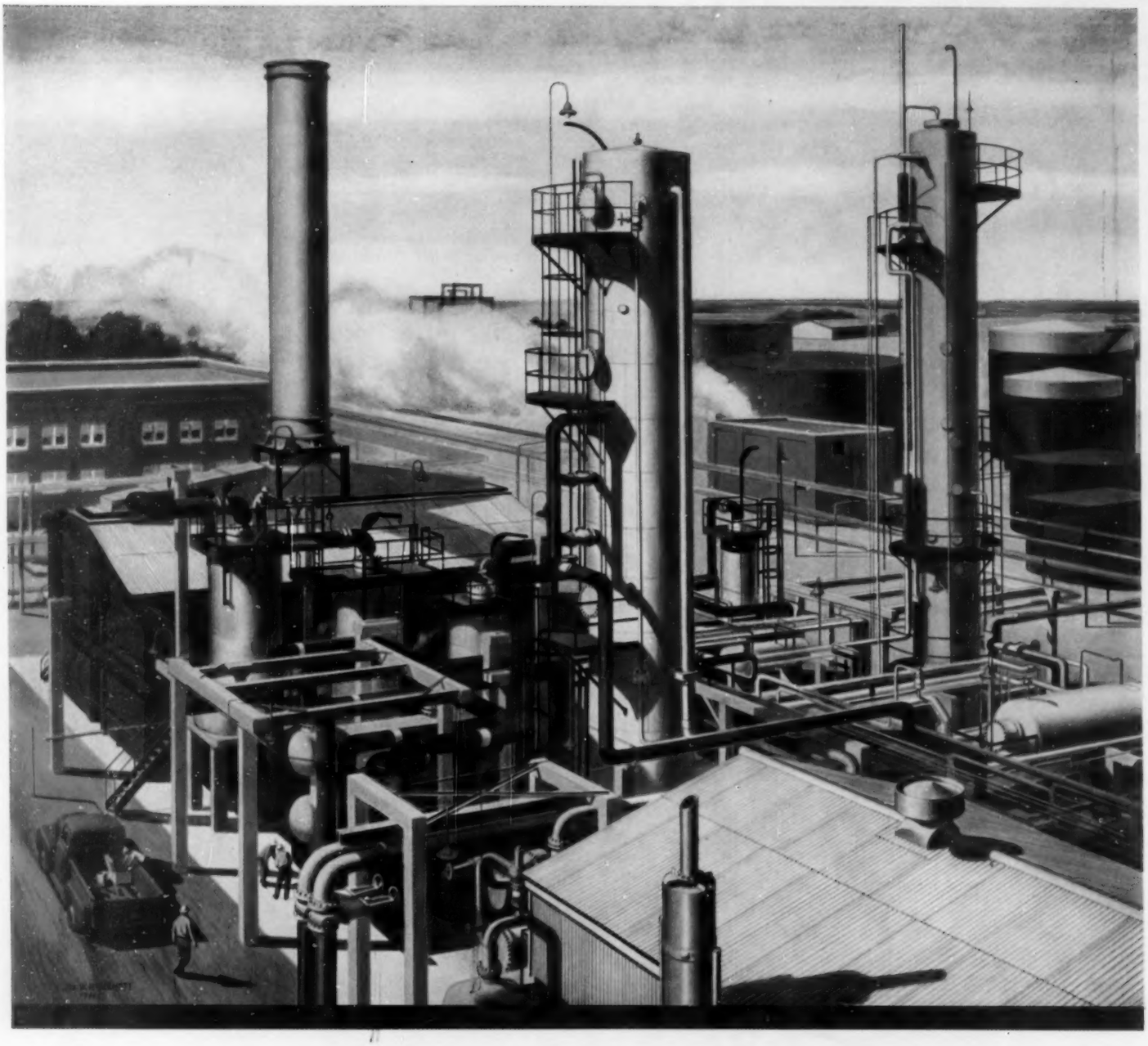

CROWN CENTRAL REFINERY

Crown Central Petroleum Corporation's new Houdriformer at its Pasadena Refinery near Houston, Texas is designed primarily for upgrading naphthas to produce high octane motor gasoline. Further processing makes possible the commercial production of aromatics and aviation blending stocks.

A feature of the Crown Central catalytic reforming unit is a "guard case" to desulphurize and pre-treat charge stocks. This small reactor is an integral part of the Houdriformer unit and strips the stock of contaminants, thereby eliminating the need for complicated pre-treating processes.

A new brochure on the Houdriforming Process is available on request. Write to: Houdry Process Corporation, 1528 Walnut Street, Philadelphia 2, Pa.

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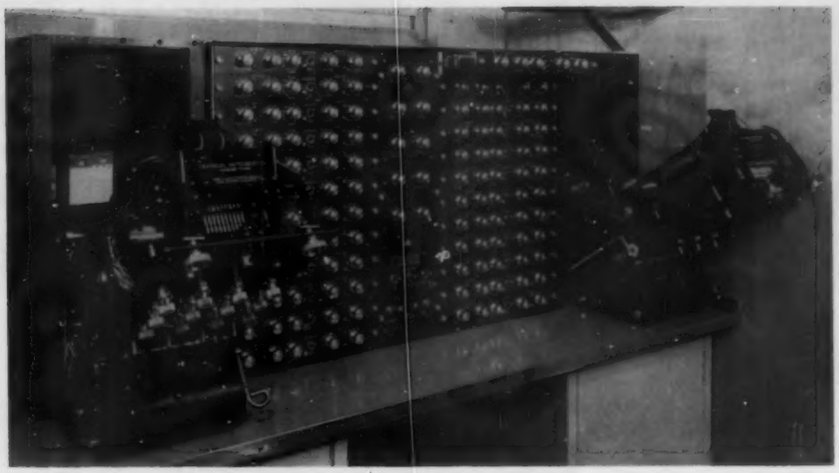


Fig. 10—*Final record oscillograph records the final filtered and corrected record ready for the computer. Is available with from 25 to 50 traces on from six to 10-inch paper.*

Fig. 11—*Recording oscillograph manufactured in England.*

Fig. 12—*The EVP-1 pressure sensitive geophone.*

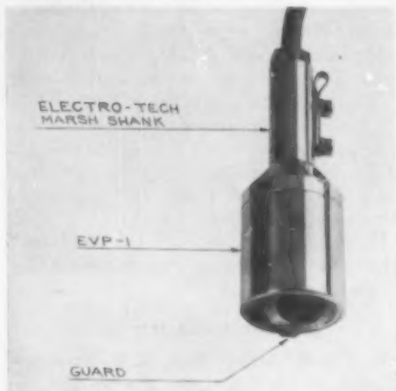


Fig. 13—*Ampex moveable head assembly.*

added to provide excellent mechanical coupling to the water. More than ten geophysical groups have field tested the geophone.

MODEL 305 GEOPHONE

Century Electronics & Instruments, Inc., Tulsa, introduced Model 305 light weight seismometer during 1955. It is designed so that rough handling and extremes of temperature and humidity have no effect on performance. All are virtually identical in their electrical characteristics, hence, errors due to phase delay or differences in amplitude are obviated, thereby preventing possible misinterpretation of seismic data.

Century also introduced to the industry in 1955 the Model 410 Portable Recording Oscillograph, accommodating 12-inch width recording media with 50 active traces, packaged to be universally adaptable to portable field applications on vehicle-mounting. It was designed primarily for system operation in conjunction with Century Model 510 Amplifiers as the uphole amplifier, time-break circuit, and voice-communication channel are integral, but can be utilized in any recording system.

GAMMA-R GEOLOGICAL LOGGER

Century's Gamma-R Logger is designed for logging bore holes in petroleum, uranium, and other mineral exploration. Basically, the unit produces a highly accurate and detailed log of the natural gamma ray radiation and electrical resistance of the geologic formation surrounding a bore hole. Both parameters are recorded against depth, a feature which permits rapid interpretation and accurate correlation with other logs. By logging both gamma radiation and resistivity, simultaneously, the resultant log provides information with respect not only to the stratigraphy and lithology, but permits determination of radioactive mineralization present.

The simultaneous log of both natural radioactivity and electrical resistance allows the user to obtain a complete picture of the bore hole in one trip of the probe. It requires only one man to operate and maintain the equipment. Mounted on a four-wheel drive vehicle, the unit is rugged enough to permit use over almost any type of terrain.

MOVABLE HEAD DRUM TRANSPORT

To make possible the elimination of such variables as step-out time and the effects of the "weathered" or "low velocity" layer in the analysis of magnetically-recorded seismic information, Ampex Corp., Redwood City, Calif., has perfected a movable head assembly for its Model 700 seismic drum recorder, which is interchangeable with fixed heads of this model.

This head assembly, designed primarily for laboratory use, permits the time relationships among all of the geophone channels to be varied as necessary to remove such variables from consideration. The ability to vary timing relationships among channels also permits the use of development of new analysis techniques of a correlative nature.

As shown in (Fig. 13) there are 26 stainless steel bars, each mounting a magnetic head. These bars, which are guided by three grooved stainless steel cross members, can be moved over a distance of ± 0.75 inch, which corresponds to ± 100 milliseconds at the tape velocity of 7½ ips.

Connections to the heads are made by means of printed-circuit terminal strips and flexible leads attached to connectors. Plugs from the latter lead to the record-reproduce amplifiers.

Each head bar has a series of teeth cut into it, which in conjunction with a cogged wheel allows the bar to be adjusted. The cogged wheel can be positioned over any of the 26 heads; when not in use, it is sta-

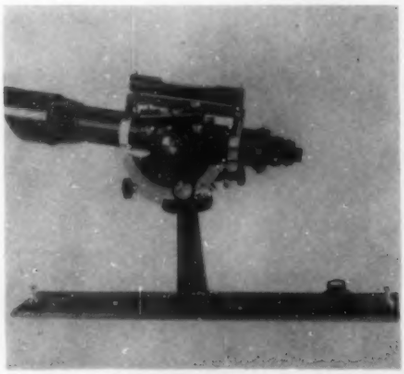


Fig. 14—*Curley explorer's alidade features internal focus.*

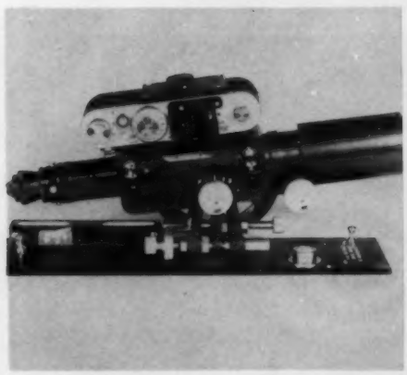


Fig. 15—*Photo Alidade.*

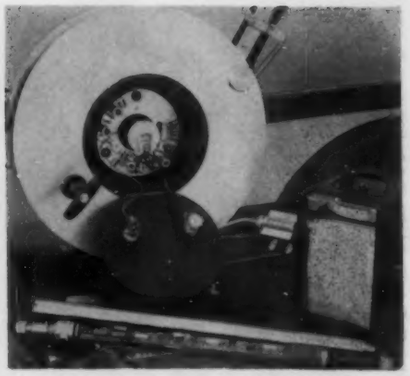


Fig. 16—*Gamma-gamma logger for core and shot holes.*

tioned to one side and rests on a pad. This position of the wheel locks down the head bars by means of a friction clamp. Positioning the cogged wheel on any head bar automatically releases the lock.

The desired position of each head bar relative to its companions can be set to within ±1 millisecond accuracy by use of the engraved lines on the bar and the lucite overlay. The top engraved line (which has a dot on either side of it to make it readily discernible) is set under the 10 millisecond line of the lucite overlay that is closest to the desired time correction. The vernier scale on the head bar is then used to adjust to the nearest millisecond. The design of the head assembly is such as to minimize the effects of parallax.

Provisions are also included for introducing the desired time corrections rapidly by means of templates.

INTERNAL FOCUS ALIDADE

W. & L. E. Gurley, Troy, N. Y., have developed an internal focus alidade for geologists, topographers and explorers. (Fig. 14) The much larger objective lense on the internal focus instrument admits more light and allows a greater field of vision. Since the objective lense is stationary, the telescope is protected from dust.

PHOTO ALIDADE

The U.S. Engineering Company, Dallas, has developed the Photo-Alidade which was designed and built specifically for use on seismic crews. (Fig. 15)

The instrument is operated in the same manner as a conventional alidade as far as field readings are concerned. In addition, a picture is snapped of each back sight and fore sight which provides a permanent film record of all readings taken by the instrumentman. Each picture records the rod reading, stadia intercept for distance and the vertical arcs with vernier for elevation differences. The camera uses standard 33 mm film, is easy to operate and will not take double exposures. The camera also comes equipped with a special data recording optical arrangement whereby the party number, date and area and other vital information may be superimposed onto each frame of film for purposes of correlation with the surveyor's field notes.

The main advantage claimed for this instrument is that it provides a positive means of detecting and eliminating compensating errors in a seismic survey. Such compensating errors can not only create pseudo structures but can mask the presence of true structures.

THE MORAN GAMMA LOGGER

The Moran Gamma Logger is a complete motor driven scintillation counter logging unit designed especially for probing shot and core holes by Moran Instrument Corporation, Pasadena, Calif. It can be mounted rigidly on a drill rig or supplied with a portable mounting base for installation on the bed of a pickup truck, jeep, or station wagon. The complete unit with 1,500 feet of cable weighs less than 160 pounds. All power for operating the motor and recording unit can be furnished by a standard automobile battery.

The instrument is designed for the most rugged field use. The assembly consists of a power driven reel and extending arm, an adjustable pitch metering pulley which drives a footage counter and radiation level graphic recorder, and a stainless steel probe housing the scintillation counter. The extending arm can be swung horizontally so that the probe is easily centered over the borehole without further realignment on the carrying vehicle. (Fig. 16)

The instrument is designed to give an accurate, repeatable stratigraphic log which will delineate sands, shales, and other lithologic units. At the same time it can be used to evaluate zones of radioactive mineralization or uranium ore without heavy capital outlay for separate logging trucks or cumbersome and complicated equipment.

THREE SEISMIC SYSTEMS COMBINED

Southwestern Industrial Electronics Co., Houston, has announced the new G-33 Full-Spectrum Seismograph System which combines in one instrument all the functions previously filled by three separate seismograph systems. Since it covers the seismic spectrum over the entire range of frequencies from 4 to 600 cps, the G-33 can be used for refraction, conventional reflection, and high-frequency recording with no additional equipment required. The new system utilizes all of the techniques employed in the G series equipment to attain low distortion and low noise level characteristics, as well as light weight and small space requirements. (Fig. 18)

Filtering covers this wide-band with two attenuation rates for both high and low frequency cuts. Automatic gain control time-constants are provided for each recording technique. A variable speed oscillograph allows the use of the same instrument in all three applications. Critical components are hermetically sealed.

The new instrument is claimed to provide magnetic or photographic recording at less than half the cost of the three separate systems it replaces.

SIE MAGNETIC RECORDERS

Magnetic recording equipment for seismic data has continued to be the leading concern of the SIE research and development department during the past year. The earlier MR-4 system has been joined by two new systems. (Fig. 19)

A new MR-5 is used for laboratory analysis as well as for field recording. Records can be composited with the MR-5 by

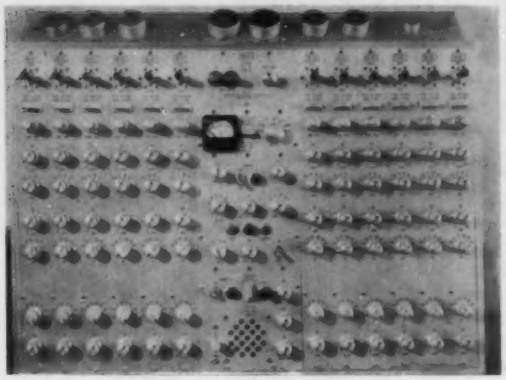


Fig. 21—*G22-A Seismograph System Master Unit.*

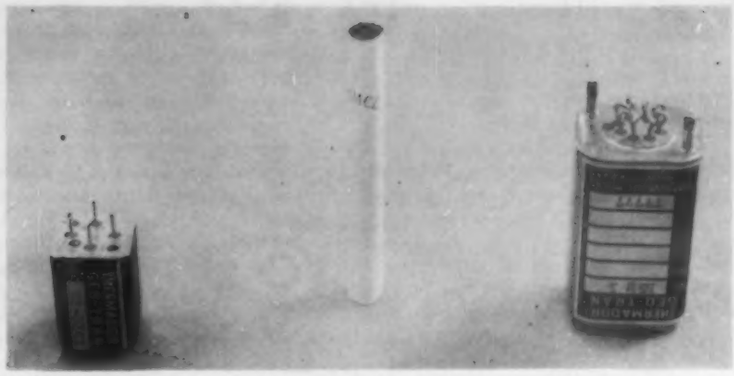


Fig. 22—*Sub-miniature and sub-sub-miniature transformers.*

use of the two drum transport systems, and the movable recording heads. The SIE normal-moveout remover is an auxiliary device which is used in laboratory analysis of magnetic recordings. (Fig 20)

SIE has also completed a light-weight portable magnetic recorder, the PMR-6 which can be carried into areas which are inaccessable to vehicles. The PMR-6 uses the same recording tape as the MR-4 and MR-5 recorders.

G-22A SEISMOGRAPH SYSTEM

The SIE G-22A seismograph system includes features as standard equipment which were available only as special equipment previously. Operating and amplifier matching procedures have been greatly simplified. AGC time-constants, mixing method and percentage, and type of record presentation are selected from the front panel. Hundreds of filtering combinations are provided. (Fig. 21)

Use in magnetic recording applications is aided by the wide frequency range (within 3 db from 10 to 500 cps) and low distortion of the G-22A (less than 1 percent). AGC control range is from 0.5 microvolt to 0.1 volt input. Three time-constants are selected from the front panel.

GEOPHYSICAL TRANSFORMERS

Thermador Electrical Manufacturing Company, Los Angeles, has been developing geophysical transformers in the subminiature, and sub-sub-miniature designs as illustrated in the accompanying photograph (Fig. 22). The transformer to the left of the cigarette is a matching transformer for a transistor—Primary 20,000 ohms, and secondary 1,000 ohms. The transformer on the right is an input transformer, 500 ohm line to 157,000 ohm secondary, magnetically shielded with humbucking construction.

Fig. 18—*G-33A Full Spectrum Seismograph System.*

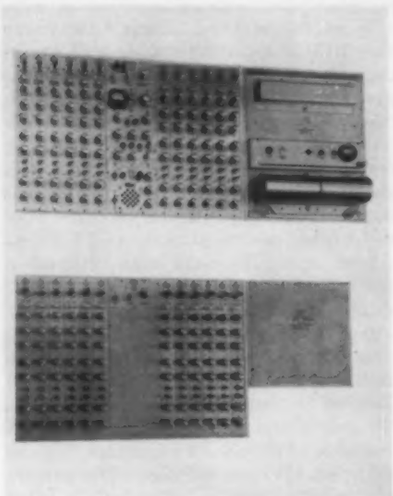
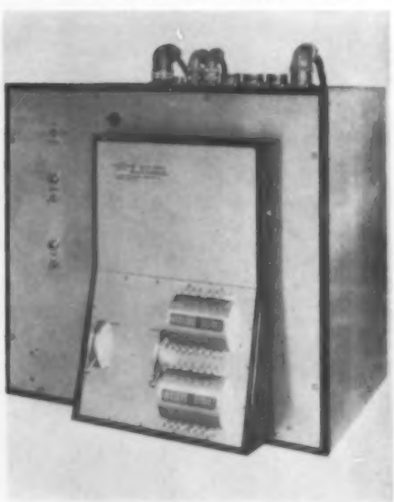


Fig. 17—*The slitting of special geophysical tape belts in the plant of ORRadio Industries, Opelika, Alabama.*

Fig. 19—*MR-4 Magnetic Recorder.*

Fig. 20—*MR-5 Magnetic Recorder.*



Record World Exploration in 1956

(Continued from page 68)

1955 and an intensified exploratory program in the Marche region.

Somicem is charged with exploration and drilling in south and central Italy and is carrying out geological and gravimetric surveys in Publie, in southeast Italy. It will soon start seismic work on the Salentine peninsula at the extreme south of the region; seismic crews are working for Somicem at present in central Italy, near Urbino and Jesi in the Marche (Adriatic coast) region.

In Sicily the majority of the island is now covered by concession or concession applications. There have been no recent discoveries following Gulf's Ragusa find of several years ago which on January 11, 1956 was announced to have produced its millionth barrel of oil. Reserve estimates by Gulf are 55 million barrels proved with 102.2 million barrels possible, considerably below Italian government estimates.

Some 28 companies are represented in Sicily now including Standard Oil (N.J.) and British Petroleum. Societa Gulf Italia, the Gulf subsidiary, holds the only exploitation concession. The Italian government is beginning exploratory drilling through AGIP-Mineraria at Gela, in south Sicily.

Exploration in France received a tremendous impetus from the Parentis discovery in April 1954. Among the companies which subsequently entered French exploration were Caltex, D. D. Feldman Oil and Gas Co., British Petroleum, Socony Mobil, and Royal Dutch/Shell.

Considerable footage was drilled during 1955 by the various operating companies. A total of about 480,810 feet was drilled in 1955, which over 14,190 was drilled by Ste. Nationale des Petroles d'Aquitaine (SNPA), followed by Esso REP with 11,080 feet during the year.

One of the various companies owned by the French government, Regie Autonome des Petroles, obtained shows of oil May 8, 1955 at Briod in the Jura Mountains of eastern France. Later news was less encouraging. Daily production fell from about 400 cubic meters of gas and about two barrels daily to even less insignificant proportions of oil and little gas. Another government company, Pechelbronn, reported shows of oil during late 1955 in Bas Rhin department. The depth of the reported discovery was about 4,592 feet and initial production 880 barrels on a 10-hour test. In Alsace another government company PREPA (Societe de Prospection et d'Exploitation Petrolieres en Alsace) announced a successful well about six miles west of Mulhouse in Alsace in Reinigue 1 well. Depth of the pay was about 4,275 feet and a test on Oct. 22 indicated about 80 b/d production of light oil similar to that of Staffelfelden. The high percentage of water obtained during production led to deferrment of a following well pending seismic study.

In the Parentis and Mothes areas where Esso REP is operating considerable exploration is underway by the company. Esso gave up 50% of its concession in early February 1956 and application for the surrendered area already had been filed by several companies before the area was given up. The parcel retained by Esso is the southern half, with two blocks kept of the original northwest portion of the concession area. The total area retained is about 8,500 hectares.

Esso has three wildcat wells drilling, plus two developments wells. At the beginning of 1956 the company completed St. Paul No. 1. Total well depth was 9,790 feet. The well is north of the village of Mimizan. No shows were reported. The rig was moved to Liposthey, 14 kilometers east and one kilometer south of Parentis No. 1 where it is now drilling. Another well is being drilled 12 kilometers north of Parentis Lake's east tip, known as the Sanguinet well near the village of the same name.

A third well is drilling six kilometers, south and eight kilometers east of Arcachon Bay or 28 kilometers north and two kilometers west of Parentis No. 1. This is known as the La Teste de Buch well.

During 1956 Esso plans to keep two rigs busy with exploratory drilling. Four seismograph crews which were operating in 1955 will operate through 1956. The cost of their operation is reportedly very high.

Other companies are continuing exploration actively with six rigs operating in the Paris basin. Of these two are run by Regie Autonome des Petroles (RAP) two by Societe Nationale de Petroles d'Aquitaine (SNPA) and two by the Compagnie d'Exploration Petroliere, formerly known as SNPLM. In the Aquitaine basin nine rigs are operating, in addition to Esso's. Six of these rigs are being run by SNPA and one by RAP. Two are operating for the Societe de La Garonne. More activity will occur during 1956 when Cie. des Petroles de Guyenne begins operations on holdings in southwestern France. This company is owned by Shell Francaise, Pechelbroon, SAEM and Cie Francaise des Petroles. It also holds areas in the departments of Lot, Dordogne, Lot et Argonne and Tarn et Garonne, just northeast of the Parentis field.

In Austria the biggest event was the return of the Austrian oil properties in August to Austrian control. The oil companies represented are being compensated for their installations, but exploration rights over the potential territory of eastern Austria are restricted to Austrian companies. Exploration has begun in other parts by companies, especially the RAG company which is owned by Shell and Socony Mobil and has begun exploratory drilling in that part of Austria not affected by the treaty, located in upper Austria/Slatzburg province around Puchkirchen.

German production has expanded slowly under the impetus of a continuing exploration effort with the discovery rate about the same as in previous years. Seven new fields were discovered during the first 10 months of 1955, compared with 12 new fields during 1954. The main production areas are the Hanover area and the Emsland area near the Netherlands border, but there have recently been very rapid increases in two other parts of the northwestern Germany, especially in the Weser-Ems area and northeast of Hanover. In southern Germany several small fields have been found in the Molasse Basin, a new producing area. Among the northern finds was Deutsche Erdoel-AG's Kiel 4 well about ten miles northwest of Kiel which produced about 62 to 75 b/d from between 5,750 and 5,800 feet.

In Portugal the entire country is held under concession by the Companhia Dos Petroleos de Portugal, which has concluded an operating agreement with Socony Mobil. Under the agreement Socony is the

Offshore exploration in the Persian Gulf necessitates underwater gravity surveys. Shown is a diver equipped with the Cousteau "Aqualung" examining the position of a submarine gravimeter (Photo courtesy of British Petroleum Co.)

operator. Some exploratory wells have been drilled, but no commercial discoveries reported. One well was drilled in 1955 near Torres Vedras with no shows reported. Another is planned during 1956.

Exploration in Spain has not resulted in any discoveries of commercial importance to date, however an intensive exploration effort is underway by General American Oil Co. of Texas. The company is owned 10% by Caltex, 10% by DeGolyer and McNaughton, 5% each by Delta Drilling, Lion Oil, Bear Stearns and E. E. Gogelson. This company benefits from a 1952 temporary decree which reserved all of exploration in Spain (excepting some minor concessions granted before 1952) to the government through Instituto Nacional de Industria (INI). General American is a partner with INI in an arrangement when a joint company known as Valdebro explores freely throughout Spain on a 50-50 participation of exploration costs, with INI paying expenses in local currency and getting government facilities for the effort and the American group providing technical aid and meeting dollar expenses. The company has reportedly set up a $10 million program for the next five years and has drilled three dry holes to date. At present seismic and gravity surveys are underway and drilling crews are operating near Ecija in Sevilla province, near Burgos and near El Puerto de Santa Maria in southwestern Spain. The Ecija test reportedly has natural gas shows.

Another concern, Empress Adaro, which is government-owned, has been exploring in the Pyrenees provinces of Huesca, Lerida and Barcelona as well as in Guadalajara and Spanish Morocco and reportedly found some gas near Guadalquivir and between Giron and Villaviciosa. Another company, CIEPSA, is associated with the German company, C. Dielmann Bergbau G.m.b.H. and reportedly obtained gas shows in its Gastiain well in Navarra province.

In the United Kingdom the 1,200 b/d level of production is only held by intensive drilling of small fields. There are four companies exploring at present. Esso Petroleum Co. Ltd. holds rights to a small area in the north near Edinburgh. Steel Brothers holds five areas designated as A189 through A193, just northeast of Liverpool. Imperial Chemical Industries Ltd. holds three small areas in the vicinity of Middlesborough on the east central coast of England. The largest is D'Arcy Exploration Co., which has extensive holdings in central and southern England and has one smaller area near Edinburgh.

D'Arcy discovered a small new field in 1955 in the east Midlands at Egmanton, six miles from the company's Eakring field in Nottingham. Three wells were drilled in the field during 1955 and one completed during early 1956. At the Plungar field in Leicestershire two additional wells discovered production to make a total of four producers. Extensive exploration for natural gas was carried on by D'Arcy in 1955. Included was a survey of the Cheshire basin and a second deep exploratory well at Crowborough in Sussex. A new location has been spudded near Hunmaby in Yorkshire.

Asia and Australasia—The principal development in Asia was the entry of independent American capital into Pakistan for exploration. Agreements were signed for exploration over a total of 20,000 square miles comprised in 18 areas by Hunt interests. The government of Pakistan took a 25% share in exploration costs and production under the concessions. The concession areas lie along the coast of the Arabian sea west of Karachi toward the Iranian border, and in the Indus River Valley north of Karachi.

Standard Vacuum has 20,000 square miles under concession in Pakistan, obtained in 1954, and covering about nine separate areas. A rig is to be moved in by June 1955 to west Pakistan. American Overseas Petroleum, owned by Caltex has 16 applications pending for about 13,000 square miles in west Pakistan and about 10,000 square miles in the Indus Valley of east Pakistan.

Pakistan Petroleum Ltd. a subsidiary of Burma Oil, has planned three exploratory wells in the near future, one of which is drilling in east Pakistan near the site of the Haripur well; one near Drig road near Karachi, and another in the Zharipur division of Pakistan.

Exploration in India continues to be retarded by governmental attitude. Only one major American company is in India at present. Standard Vacuum operates under a joint arrangement with the Indian Government, and holds a 10,000 square mile concession adjoining its acreage across the border in east Pakistan. Developments during the year included the failure of Assam Oil Company's ninth and tenth wells at Nahorkatiya at 10,950 and 9,775 feet respectively in upper Assam. This field was discovered in 1953 and was the last good strike in India to date. The dry wildcats eliminated some of acreage previously thought potential but Nahorktiya No. 11 came in during early 1956 at 9,600 to 9,785 feet to be the field's eighth producer. A good well was also completed in the old Digboi field during the year.

Governmental participation in oil exploration was increased with the formation of the Oil and Natural Gas Division of the Department of Natural Resources with about $18 million to spend over five years. A new government-private company was formed with Assam Oil, a subsidiary of Burmah Oil Co., for oil exploration during the year.

Assistance was offered by both Russia and Rumania in oil development and exploration and seven oil specialists were received from Russia. A recent amendment to the constitution authorizing exploration and sponsored by the government raised doubts about oil's future in India. The amendment specifically mentioned oil and mineral development as one in which the government should have full and complete control.

Exploration in Australasia was highlighted by two encouraging discoveries, one an oil well in British Borneo and the other a gas find in Papua. In British Borneo, a British Protectorate where Shell's subsidiary British Malayan Petroleum, has about 110,000 b/d production, a discovery was made at Jerudong in Brunei at a depth of about 3,500 feet. The well is located about 45 miles northeast of Seria field, the main producer. Production was 850 b/d through a 3/8-inch choke. Offshore work is in progress in Seria at present.

Exploration in Papua was highlighted by the discovery of substantial gas in Kuru No. 1 by Australasian Petroleum Co. and Island Exploration, owned by British Petroleum, Standard Vacuum and Australian interests. The gas was found at 998 feet and pressures were high enough to require special equipment and assistance. The companies plan substantial expenditures in Papua, continuing a 20-year exploration program. Previous wells, known as Omanti Nos. 1 and 2, both on the Darai anticline were dry. Another, Aramia No. 1, was also dry in September 1955 and abandoned at 6,614 feet. Two wells on the Barikewa structure and the Morehead area are scheduled for 1956. The exploration program planned through 1957 includes extensive geological and geophysical surveys and four wells, plus an aerial survey of 4,000 square miles; three reconnaissance surveys, three surveys for detailing known structures, a shallow hole core drilling program in the south of Turama River; two geophysical surveys, and one gravity party in western Papua.

In Australia the failure of additional wells to find production in the Rough Range area, where a 500 b/d well was discovered in December 1953, has not caused West Australian Pty. Ltd. to curtail exploratory effort. The company is owned by Caltex and Ampol, an Australian company. After coming successively closer an additional well only 30 feet from the discovery brought in production, but considerable water was produced with the oil and there seems to be no possibilities left that this was a major discovery. Gas shows were encountered in Cape Range No. 2 at 9,886 to 10,098 feet.

Four core holes were drilled as part of a survey on Dirk Hartog Island off the coast of western Australia. In south Australia a well in Gippsland, Victoria by Frome Lakes Pty, owned by British Petroleum, Standard Vacuum and Zinc Corp. (an Australian company) was abandoned at 4,730 feet without discovery. Wells in the Longreach and Warbreccan areas of Queensland were abandoned without discovery and another well near Brisbane was abandoned at 3,699 feet. Wells near Reid's Dome also were dry on the first two attempts, a third was drilling in early 1956.

Oil shows were encountered by South Australian Northern Territories Oil Syndicate at 800 feet. The well is Wilkatana No. 1 near Port Augusta in south Australia.

Exploration in the Philippines is reviving after a lull of some years. An exploratory well was spudded in January 1956 by Philippine Oil Development Co. (PHODCO), owned by local capital. Caltex is making a contribution on the hole which is located on one of several well defined structures in the Cagayan Valley of Luzon Island. Among the other companies interested in the Philippines are Standard Vacuum, Caltex, San Jose Oil Co. and Luzon Stevedoring. American Overseas Petroleum Ltd., a subsidiary of Caltex, transferred its rights in the Luzon Valley well to two affiliates of Caltex' parents, Texaco Overseas Petroleum and California Asiatic Oil, which recently received exploration concessions totaling 1,235,000 acres in Luzon and are undertaking exploration.

A conflict over concession rights in the Luzon Valley between PHODCO and Standard Vacuum was resolved in 1955 by giving one-third to PHODCO (where their present well is located). Provision was made for sharing of the other two-thirds by an arrangement where each company received half with option of receiving one-third of the production the other might obtain on payment of one-third of the expenses incurred in developing any production.

An exploration program in New Zealand was announced with agreement between Shell interests and Todd Brothers Ltd. of Wellington to explore prospecting licenses in the Taranaki and Rangetikei areas of central and western districts of the North Island. British Petroleum will contribute half of $2.8 million for exploration through an operating company known as Shell D'Arcy Todd Oil Services Ltd.

In Indonesia exploration operations have been curtailed to development of existing fields. The three principal companies are Caltex, Shell and Standard Vacuum. The latter announced during 1955 a $80 million expansion program but until new areas are opened to concession, none of the companies can invest heavily in exploration programs. The Shell Group announced it would be willing to undertake a large scale exploration program if its northern Sumatra fields were returned, but to date no action has been taken on this question by the government.

Western Hemisphere

Latin America—Exploration in Latin America during 1955 and 1956 has been overshadowed by government action. Venezuela announced that exploration concessions will be granted "as soon as possible" and oil men in Caracas felt that this time new concessions were really imminent. Several countries opened the doors to private foreign investment in oil exploration, including Guatemala and Bolivia and new incentives were offered in Colombia. The door remained closed in Brazil, however, and in Argentina it seemed to be opening and then closed again, very firmly. Chile still had made no progress in relaxing one of the oldest petroleum monopolies in the world.

Central America was receiving considerable attention, for the first time in some years. Guatemala opened for exploration by foreign companies with passage of a new petroleum law, replacing the restrictive Decree 649 which resulted in the withdrawal of companies in 1949. A number of companies filed application for concessions, most of them over the Peten region of northeastern Guatemala which is a flat, tropical, jungled area with the best geological prospects. Companies which have applied in Guatemala and the number of their concessions under the new law are as follows: Guatemalan Atlantic Corp., 1; Tide Water, Guatemala, Ltd., 1; Sohio Caribbean Co., 3; Petroleum Investment (Overseas) Ltd., 1; The Ohio Oil Co. of Guatemala, 3; Amerada Petroleum Corp. of Guatemala, 2; Inversiones Guatemaltecas-Americanas, S.A., 1; Continental Oil Co. of Guatemala, 1; William Lawrence Norman Stone, 3; Sun Production Co., 2; Halbert & Jennings, 4; Seaboard Exploration Co., 4; Archer Oil Co., 4; Shawano Development Corp., 4; A. K. Swann, 10; Garfield & Pasternak, 10; Esso Standard (Guatemala) Inc., 3; Petroles Guatemaltecos, S.A., 6; Bandini Petroleum Co., 1; Jaime Allan Willard Duran, 1; Texas Petroleum Co., 2; Union Oil Co. of Calif., 4; Compania Petrolera California Ltd., 8; Signal Exploration Co., 4; Story J. Sloane, 4; Central American Oil and Mining Co., 1; Antonio Molina Murillo, 1; Petroleos Atlas de Guatemala, S.A., 1; Compania Petrolera Guatemalteca, S.A., 1.

The rush of concession applications was so heavy that the government announced no new ones would be accepted for a two month period while overlapping areas were allocated.

In view of the interest in Guatemala exploratory drilling in neighboring countries of Central America was being followed closely. In British Honduras Gulf Oil's subsidiary, British Honduras Gulf Oil Co., holds an oil exploration license over the entire country, obtained in 1949. The company spudded an exploratory well, Yalbac No. 1, on June 20, 1955. No drilling reports were available on the well. It was reported abandoned due to a fishing job at about 6,100 feet early in 1956 but this report was denied by the company. The well is located about 65 miles west of the capital, Belize.

In Costa Rica the Union Oil has been carrying out an active exploratory drilling program through its subsidiary, Cia. Petrolera de Costa Rica, Ltd. The company has a concession covering the provinces of Limona and Guanacaste, signed Nov. 9, 1951. The company drilled the first well, Patino No. 1, near the Panama border. It was abandoned dry at 6,754 feet. Patino No. 2 was begun during 1955 and also abandoned. A third well, Bris No. 1, was spudded Aug. 23, some 25 miles from the Caribbean coast and only about half a mile from the border of Panama. Bris No. 1 was also dry, and a fourth well is beginning on a different structure, known as Cocoles No. 1. It was reported to have found shows of oil and gas at 3,729 feet during January, 1956. This well is located approximately three miles from the border of Panama.

In Haiti the Commonwealth Oil Co. drilled an exploratory well on Ile de la Gonave, an island about 30 miles north of Port-au-Prince. The well was abandoned at 3,158 feet when drill pipe twisted off. A second is now being completed below 7,500 feet halfway up the slope of the island anticlinal structure.

In Jamaica Stanolind signed an agreement with Base Metals Mining Corp., a Canadian corporation, covering exploration in Jamaica and surrounding waters, with provision for minimum expenditures of $2 million over the 8,600 square miles of licensed areas by June 21, 1958. Of the sum about $1 million was to be expended on drilling, exclusive of geological or geophysical work. The Base Metals company completed a wildcat during June 1955 at 6,300 feet on the western tip of the island near Negril. Oil and gas shows were reportedly obtained. Base Metals retains a 25% interest in the Stanolind venture.

In Trinidad the high point of recent exploration was the Paria Gulf discovery by Trinidad Northern Areas, Ltd., owned by United British Oilfields (Shell Group, Trinidad Leaseholds and D'Arcy Exploration (British Petroleum). The well became a typical "Trinidad producer," reported at 160 b/d. It was located about six miles off Cedros Point on the southwestern corner of the island, completed in mid-1955. Water encroachment reportedly caused abandonment of the first producing horizon. A submersible barge began operations off Point Ligoure in the Gulf of Paria during late 1955. It is owned by Antilles Petroleum Co. (Trinidad) Ltd., a subsidiary of McColl-Frontenac Oil Co. Ltd. controlled by The Texas Co. Agreement was reached between the companies and the government on royalty rates, a long-standing question in Trinidad. Depletion allowances were given to offshore producers by the government in early 1956.

In the Caribbean area interest centered on Cuba. Following the discovery of deep Cretaceous production in 1954 three miles north of Jatibonico, the island has been in an exploration boom. The original Jatibonico discovery has been drilled up to produce about 1,200 b/d. During 1955 Stanolind Oil and Gas Co. entered Cuba under an agreement to explore about 12 million acres of concession area held by Cuban-Venezuelan Oil Voting Trust and Cia. Petrolera Trans Cuba. Stanolind contracted to spend $10 million over five years in exchange for 50% rights over the area.

Another exploratory development occurred when a well drilled by the Ted Jones Drilling Co. near the old Bacuranao field came in for about 125 b/d production on Dec. 2, 1955 at Santa Maria del Mar, 12 miles east of Havana. Pay zone was brown

Dolomite at 2,510 to 2,542 feet. Crude produced was about 16.5° API gravity. Considerable gas was also found.

In Barbados, Gulf Exploration Co. drilled an exploratory well to below 10,000 feet in its Springvale No. 1. The well is in the Scotland area of Barbados, near the center of the island. The company abandoned a previous well, Adams Castle No. 1, at 5,596 feet during March 1955.

In South America interest centered on Argentina during the first half of 1955. A proposed contract with Standard Oil of California covering about 19,100 square miles on the lower tip of Argentina failed of approval by the Sept. 30, 1955 deadline. With the overthrow of the Peron regime the last hopes for conclusion of the contract were lost when succeeding presidents reaffirmed opposition to the entry of private foreign capital.

Dr. Prebish of the United Nations, summoned as advisor to the President of Argentina, supported the policy of expulsion of foreign private capital and recommended direct exploitation and exploration by the State with financing by internal sources and any foreign credits available, plus assets from other sources. The latter probably included those assets of persons considered to have benefited from the Peron administration.

Bolivia renewed interest in investment when a new oil law was passed during late 1955 designed to attract foreign capital. The law contains a depletion allowance of 27½% of gross to 50% of net. Taxation is based on the 50-50 profits split after deductions of drilling and development costs. No major company is reported to have applied for concessions.

The McCarthy interests remained in the country. The McCarthy venture was initiated in 1952 and during 1955 a half interest was obtained by the Keljikan Commercial Corp. The concession covers 970,000 acres in the Gran Chaco province of Bolivia, nearly touching Argentine border. Four wells have been drilled on the Los Monos structure which is contained. The wells are reported to produce about 200 b/d each from the Devonian at 2,198 feet in the first well and 3,150 feet in the second well. Drilling plans call for two wildcat wells on the nearby Agua Salada structure.

Production in Bolivia has increased to about 2.7 million barrels during 1955, up 60% over 1954 levels due to increased output from Camiri field's lower producing horizon discovered during 1953.

Exploration in Colombia received a boost when legislation was passed limiting the percentage of government taxation and instituting a depletion allowance. A discovery was made Sept. 7, 1955 when Lebrija No. 1 a wildcat by Intercol, in which Socony Mobil has a half interest, came in in the Middle Magdalena Valley at about 343 b/d of 27.2° API crude. The well later dropped substantially from these levels and seemed to remove the possibilities of a major strike.

In Chile the government's company, Empresa Nacional del Petroleo (ENAP), continued exploration and drilled a total of 44 wells during the first nine months of 1955, of which five were wildcats. No important discoveries were reported. The proposed petroleum law to admit foreign capital to Chilean development and exploration was not passed.

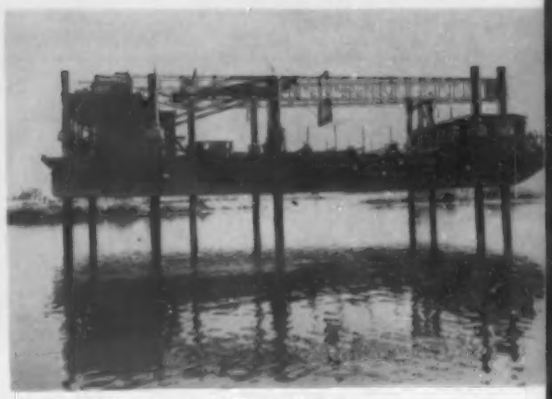
In Ecuador there were no major exploratory developments recently. Lobitos Oilfields and South American Gold and Platinum Co. of New York have reached an agreement to acquire one-third interest in Anglo Ecuadorian Oilfields. Another agreement was reached by the latter with the government extending concessions to 1977.

Exploration in Peru shifted emphasis during 1955 and 1954 to the Montaña or eastern region after some 16 exploratory wells in the coastal zone were dry. The Montaña contains some of the most difficult jungle operating areas in the world. Three wildcats during 1955 turned out dry. Marañon No. 81 was abandoned with lost drill pipe at 9,787 feet by The Texas Co. in the Marañon Basin area. A second well was spudded early this year about 150 miles downstream, known as Marañon No. 221. Ganzo Azul Petroleum Co. abandoned its initial test in the Ucayali River Valley at 1,305 feet. The third test was also abandoned. It was drilled by Cia. Peruana de Petroleo "El Oriente," a local firm. The Sechura desert, known as the Coastal Zone area, saw two more dry wells in Texas Company's Payoca Nos. 31 and 77 near Mirador.

Despite these results, seven companies holding the legal acreage limit in the Montaña region applied for additional acreage to be alloted following the beginning of 1956. In an auction of Jan. 16, 1956, International, Texas, Mobil Oil, Peruvian Pacific, Richmond, Cerro de Pasco and Oriente companies bid on about 7.5 million acres of new concessions. This raises the total area under concession in the Montaña to about 36.3 million acres, held by 15 companies. Two companies, International and Texas, each hold about five million acres.

Exploration in Brazil continued with Petrobras operating through drilling contractors and employing an American geologist as head of the exploration effort. Drilling and Exploration Co. of Nevada is supervising drilling and production activity. Considerable equipment, including nine rotary rigs, has been acquired.

The principal exploratory development was the discovery of the Nova Olinda well in March 1955, designated as Well 1-Az, on the right bank of the Madeira River about 95 miles southeast of Manaus in the Amazon River basin. Production was obtained at 8,900 feet of light 40° to 50° API crude. This was the fourth wildcat in the area, the previous wells had been at Limeiro, Chaves on Marajo Island and on Capim River, all abandoned dry. A fifth well at Alter do Chao on the Tapajos River near Santarem was discontinued in October. A wildcat in Parana, the Jacarezinho well, was reported abandoned at 8,775 feet.

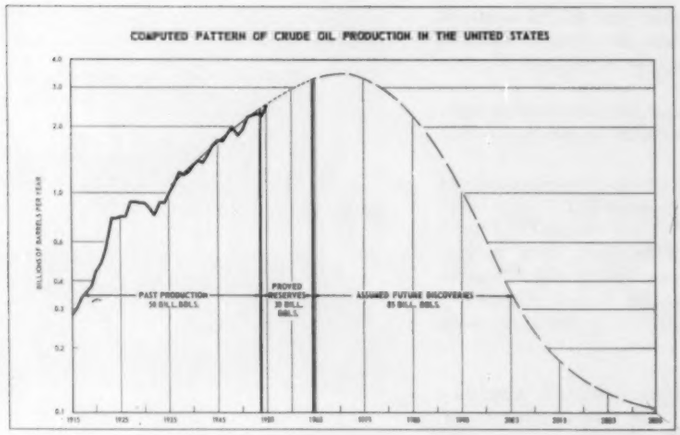


Mene Grande No. 72 elevated 10 feet above water 25 feet deep.

Geologist in Orinoco Valley, Venezuela
[Photo courtesy Standard Oil Co. (N.J.).]

The rig was transferred to Ortiguira in western Parana where it is drilling at present.

Further exploration is going on with six rigs at work in the state of Amazonas in December. The Nova Olinda well was shut in pending arrival of a depth pump. Pressures were reported diminishing. Another well was drilling a half mile away at 2,600 feet at the end of 1955. A third well 2½ miles from the latter was spudding in at the year's end. Drilling was started on the River Abacaxi, a southern tributary of the Madeira, in October and had gone to 1,000 feet at year's end. In Maranham geophysical work is proceeding in the San Luis sedimentary basin and in the San Marcos Bay. Structures are marked for future drilling in Mocambo, Queimadas, Bequimao and Guimaraes in northeast Maranham.


COMPUTED PATTERN OF CRUDE OIL PRODUCTION IN THE UNITED STATES
BILLIONS OF BARRELS PER YEAR
PAST PRODUCTION
50 BIL. L. BBLS.
PROVED RESERVES
30 BILL. BBLS.
ASSUMED FUTURE DISCOVERIES
85 BIL. L. BBLS.

Computed pattern of crude oil production in the United States on the basis of future discoveries of 85 billion barrels, the approximate equivalent of past discoveries.

WORLD CONSUMPTION to rise 73 per cent by 1965

Demand for petroleum in the United States will rise 53% by 1965 to 12.8 million barrels daily and elsewhere in the world, outside the Soviet bloc, the increase will be 103% to 12 million barrels daily according to estimates by Joseph E. Pogue and Kenneth E. Hill of the Chase Manhattan Bank, New York. The report was prepared for the Feb. 21 meeting of the American Institute of Mining and Metallurgical Engineers with the aid of Fred G. Coqueron, John G. Winger, John R. Aaker and James P. Garten of the bank's oil department.

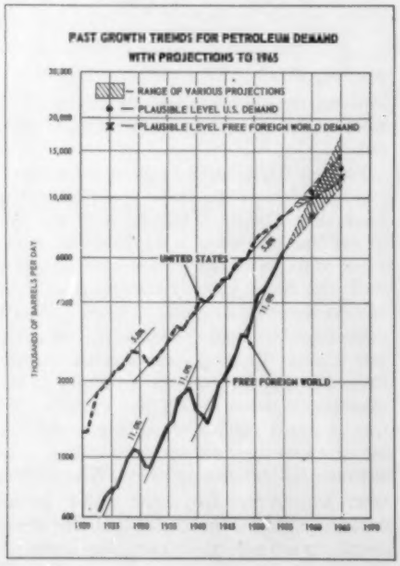
In reporting their estimates of future demand the authors observed that in the past 23 years U.S. consumption has grown at the rate of 5.8% per year compounded while "free foreign" demand has expanded at the rate of 11% per year compounded. Result is that the U.S. has consumed a progressively smaller share of the world's oil. As indicated in Fig. 1, some economists have estimated that the lines will cross in the next decade. Dr. Pogue and associates do not predict a crossing. Instead they think the lines may almost coincide in 1965. Noting that for many years the tendency of economists has been to underestimate future growth, the authors nevertheless take a median position in which they suggest that future U.S. demand will rise at 4.3% compounded annually compared with 5.8% and "free foreign" requirements will increase 7.3% compared with the historical rate of 11%. Both future rates are at about three quarters the historical rate.

Consumption is thus estimated as follows, in millions of barrels daily:

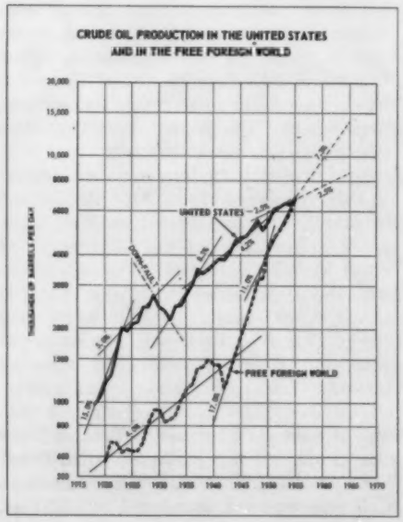
Area	1955	1960	1965	Increase 1965 From 1955
U.S.	8.4	10.3	12.8	52.7%
Others	5.9	8.4	12.0	103.4%
Total	14.3	18.7	24.8	73.7%

To supply the large increases in oil demand, Dr. Pogue and his associates have studied the probable trend of crude production over the next decade. They note that while the United States has a shut-in production of 2.2 million barrels daily, that such a rate could not be maintained over

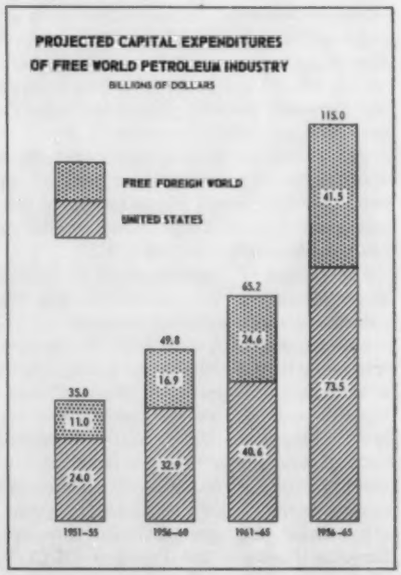
Rate of growth of oil demand in the United States and the free foreign world by years, 1920–1955, with propections to 1965.


PAST GROWTH TRENDS FOR PETROLEUM DEMAND
WITH PROJECTIONS TO 1965
RANGE OF VARIOUS PROJECTIONS
PLAUSIBLE LEVEL U.S. DEMAND
PLAUSIBLE LEVEL FREE FOREIGN WORLD DEMAND
UNITED STATES
FREE FOREIGN WORLD
THOUSANDS OF BARRELS PER DAY

Summary of projected capital expenditures for the world petroleum industry for period, 1951–55, 1956–60, 1961–65, and 1956–65.


CRUDE OIL PRODUCTION IN THE UNITED STATES
AND IN THE FREE FOREIGN WORLD
UNITED STATES
FREE FOREIGN WORLD
THOUSANDS OF BARRELS PER DAY

Trend of crude oil production in the United States and the free foreign world by years, 1917–1955, with projections to 1965.



any extended period and that the cost of finding oil has been rising steeply since World War II. Based on reports from 30 to 35 companies the cost of finding and developing new oil has averaged as follows:

Year	Cost Per Barrel	Year	Cost Per Barrel
1946	$0.84	1951	$1.41
1947	1.00	1952	1.55
1948	1.20	1953	1.58
1949	1.24	1954	1.76
1950	1.17		

The rising cost of new oil is indicated by increasing depths to which the industry must drill. Since World War II the number of wells drilled has increased at the rate of 4.3% yearly while footage has increased at the rate of 7.9%. Another factor of importance has been that oil fields discovered since the war are tending to be smaller in area than reserves. At the same time the percent of dry holes has risen to about 40% compared with 20 to 30% in the previous 20 years.

Dr. Pogue and Mr. Hill suggest that peak oil production in the United States will be reached in about 15 years and that after 1975 the rate of crude output will decline at an increasingly rapid pace.

The authors modify their future production estimates in the U.S. by adding considerable volumes of offshore oil in the next 10 years as shown in the following table.

TREND OF U.S. CRUDE PRODUCTION
(Thousands of Barrels per Day)

	1955	1960	1965
Texas—Onshore	2,880	3,170	3,520
Offshore	-0-	40	100
Louisiana—Onshore	680	900	1,000
Offshore	55	300	500
California—Onshore	975	930	870
Offshore	-0-	50	120
Oklahoma-Kansas	885	1,040	1,075
Rocky Mountains	745	900	1,015
Others	555	530	500
Combined—Onshore	6,720	7,470	7,980
Offshore	55	390	720
Total	6,775	7,860	8,700

Crude production in the free world outside the United States was greater than in the U.S. in 1955. As indicated in Fig. 2 there has been a trend in this direction since World War II and in the next decade, Dr. Pogue and associates believe that U.S. output will continue to rise at the recent rate of 2.5% per year compounded while free world foreign production will be at the increasing rate of 7.3% compounded. The smaller rate of increase in the United States will cause a rapid rise in imports of oil from abroad. In 1960 the U.S. will require 1,780,000 b/d and by 1965 3,205,000 b/d of imported oil.

There will be no difficulty in meeting world demand, the authors believe. Estimates of production outside the United States and the USSR for the next decade follows:

Thousands of Barrels per Day

	1955	1960	1955
Canada	345	650	1,000
Venezuela	2,150	2,700	3,000
Mexico	250	400	550
Others	335	450	700
Total W. Hemisphere excl. USA	3,080	4,200	5,250
Middle East	3,240	4,830	8,280
Far East	365	500	650
Others	145	250	500
Total E. Hemisphere excl. USSR	3,750	5,580	9,430
Total excl. USA and USSR	6,830	9,780	14,680

Capital requirements to meet world demand for oil in the next 10 years will total $115 billion of which $73.55 billion will be required by the U.S. industry and $41.45 billion by other free world areas. In the next five years the average free world expenditures for plant and equipment will be $3.4 billion yearly and in the succeeding five years $4.3 billion per year. The estimates are based on 1955 dollars. As in the past, the industry will generate most of its capital for expansion.

In many areas outside the United States, depletion allowances are not made by taxing authorities. The authors point out that once the period of flush discovery is past in nations which do not permit creation of reserves by depletion allowances, the growth in production is likely to be handicapped. "It is important," they say, "to avoid the consequences of an over-diversion of capital funds from the area of capital formation into less productive channels, for the accumulation of capital can thereby be crippled to the impairment of all the interests concerned."

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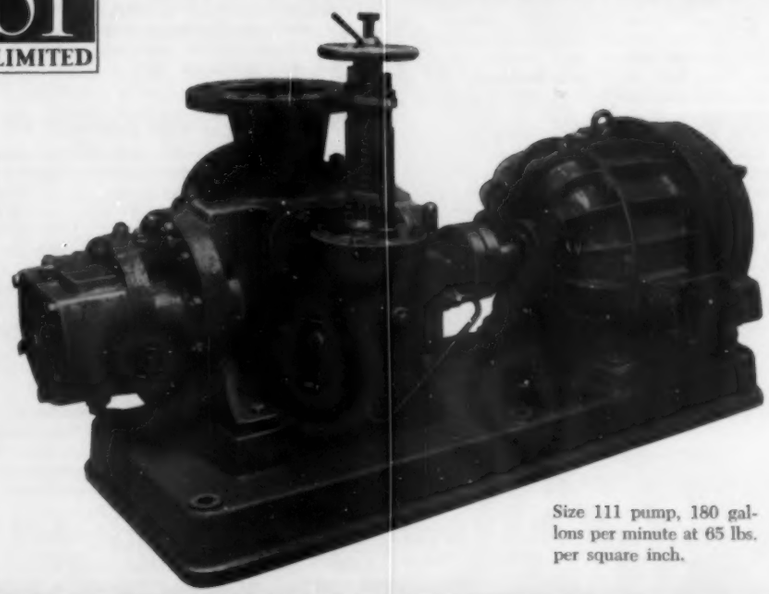

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London Letter

By E. Lawson Lomax

Exports of refined products from the United Kingdom, according to figures published by the Petroleum Information Bureau, amounted in 1955 to about 6.2 million tons, valued at $217 million. This is less than in 1954.

The largest product, in terms of value, was motor gasoline which brought in $56.8 million for 1.25 million tons exported. Fuel oil exports are less than gasoline figures for the first time at 2.8 million tons, valued at about $52.4 million compared with four million tons and $72.8 million in 1954. The decrease in 1955 is due to increasing internal demand.

Production of manufactured goods is increasing. Although greater attention is given to efficiency in fuel consumption, the quantity of fuel required by industry is increasing also. Manufacturers can no longer look to the coal industry to supply their increasing requirements, and must rely on other sources of energy. The only other sources in the U.K. are fuel oil and atomic energy, as water power has already been developed. There does not seem to be any prospect of sufficient power from atomic energy in the near future, so reliance for satisfying increased demand falls on the petroleum industry.

World production outside the United States has increased greatly over the past 30 years, as shown in figures below by the Petroleum Information Bureau.

OIL PRODUCTION—Thousand of Metric Tons

	1925	1935	1945	1955
Middle East	4,700	11,700	26,900	161,700
Venezuela	2,800	22,000	47,300	111,000
Far East	5,000	8,300	2,000	17,700
Russia	7,200	25,200	20,500	70,000

At the present time the Middle East is producing more oil than the whole of the world did in 1925.

Visible demand for fuel over future years will be mainly for black oils or residues and not for white oils or distillates. The tendency during the past decade has been for refineries to produce an increasing percentage of white oils rather than black oils from the crude oils treated. Demand is for about equal percentages of both products today. Increased production of black oil or industrial fuel, will therefore be accompanied by an equivalent production of light oil.

Because demand for light oil is not growing as rapidly as is the demand for black oil under present refinery conditions, a surplus of white oils would result, were it not for industry adaptability. Emphasis in the early part of this decade was on catalytic cracking. While it is anticipated that present plants will continue to operate, they may do so under lighter operating conditions, and 'octane ratings will be raised for straight distillates by catalytic reforming.

Expansion underway at the refinery of the Kuwait Oil Co. at Mena al Ahmadi is indicative of future trends. This extension from 30,000 to 190,000 b/d capacity is designed for higher production of middle distillates, marine Diesel and furnace fuel oils, including bunkers for tankers loading at Kuwait.

Drilling Equipment Company For U.K.

A new British company known as Security Rock Bits, Ltd. has been formed to produce Security Engineering, drilling bits and related products identical with those produced for the American markets. Engineering and manufacturing information will be supplied by Dresser Industries, Inc. of Dallas to the new organization which also includes Edeco Rock Bits, Ltd., Manchester; English Steel Corp. Ltd. and English Drilling Equipment Ltd.

Dresser Industries has also announced that they will build in America under license from Ruston & Hornsby Ltd. of Lincoln, the Ruston Mark T. A. gas turbine.

Laundry Barge by Thames Launch Works, Ltd.

Ship To Shore Truck Transportation

A twin screw Diesel engined landing craft has recently been completed by Thames Launch Works Ltd. of Eel Pie Island, Twickenham for Petroleum Development Company (Oman), Ltd., a subsidiary of Iraq Petroleum Co.

The vessel is for service in the Middle East and will be used for transportation ashore of trucks which will be loaded direct from ships lying out in deep water.

Designed by R. C. W. Courtney, of Courtney, Hughes & Partners, Ltd., the transporter has an overall length of 60 feet, moulded breadth 16 feet 6 inches and moulded depth of six feet. She is capable of carrying loads up to 30 tons on a draft of three feet six inches. Thames Launch Works Ltd. are standardizing this type of vessel, which they catalog as Thames Transporter Mark II. Average speed over a measured course is 7.98 knots. Using the rudders flat she completed the turning circle of approximately 150 feet in one minute five seconds. Using engines, a full circle was completed in her own length in 57 seconds.

Manufacture of Terapropylene Benzene in the U.K.

British Petroleum Co. Ltd. has announced that Grange Chemical Company Ltd. has been formed with Oronite Chemical of San Francisco to operate a plant for the manufacture of an alkylate (dodecylbenzene or tetrapropylene benzene) at Grangemouth plant. Plant cost was $2.8 million. It is turning out alkylate at about 10,000 tons yearly.

The process is catalytic using anhydrous, liquid hydrofluoric acid, to convert propylene tetramer and benzene. Propylene tetramer is produced in the adjoining Grangemouth refinery and in the new tetramer plant being built by British Hydrocarbon Chemicals. Pure coal tar benzene is obtained from indigenous sources.

The plant was designed by Stone and Webster Engineering Corp. of New York. Most equipment was purchased and fabricated in the U. K. Drafting and supervision were by E. B. Badger & Sons, Ltd. Construction is by Costain-John Brown, Ltd.

Dodecylbenzene is a colorless, odorless liquid. It is converted to a wetting agent and detergent by reaction with sulfuric acid. The resulting sulfonic acid is then normally reacted with caustic soda to form the sodium salt, which is the main active ingredient in most household detergent powders.

General View of the Grange Detergent Alkylate Plant at Grangemouth.

Baron Godber of Mayfield in the County of Sussex.

New Year's Honors to Shell Chairman

In the 1956 New Year's Honors List, Sir Frederick, as he then was, was created a Baron and took the title of Baron Godber of Mayfield. Lord Godber is chairman of the "Shell" Transport and Trading Co. Ltd., a parent company of the Royal Dutch/Shell Group of oil companies.

His entire career has been spent in the service of the oil industry. Born at Dulwich, London, on Nov. 6, 1888, he joined the Asiatic Petroleum Co. Ltd., (now the Shell Petroleum Co. Ltd.) in 1904 and during the following 15 years acquired experience in every important branch of the business. He spent the years between 1919 and 1929 in the United States. On his return to the U.K. in 1929 became a managing director of the Royal Dutch/Shell Group, a position which he held until 1946 when he became chairman of the "Shell" Transport and Trading Co. Ltd. Throughout World War II he was chairman of the Overseas Supply Committee of the Petroleum Board and was knighted in 1942 for his services to the Allied cause.

Dry Chemical Fire Extinguisher

A new pressure-operated dry chemical fire extinguisher which weighs less than 10 pounds when fully charged has been developed by The Pyrene Co. Ltd. It is specially designed as a small smothering unit to deal with oils and gasoline fires and can be used with safety on fires involving electrical equipment.

New Diesel Engine Cylinder Oil

The Shell Petroleum Co. Ltd. has developed a new type of Diesel engine cylinder oil. This new product, known as Shell Alexia Oil A, contains special additives to prevent corrosive wear in large marine oil engines, particularly 2-stroke engines, which has become a major problem over the last few years.

Production of highly acidic combustion products is the cause of this excessive wear. The new lubricant is an emulsion of water-in-oil, the water phase carrying an acid-neutralizing additive.

Personnels

Captain J. W. Cook has been transferred to a shore position as assistant marine superintendent for Caltex Trading and Transport Co. Ltd. W. F. Millar and J. Eltringham have also been transferred to shore positions as assistant superintendent engineers for Caltex.

N. G. Gullick of Regent Oil Co. Ltd. has been appointed sales manager, lubricants.

A. W. Wooldridge has been appointed deputy general sales manager of Esso Petroleum Co. He joined the company in 1923. In 1952 he became assistant general sales manager and in 1955 he became regional manager with responsibility for two marketing divisions, as well as for certain other head office marketing operations.

Sir Henry Wilson Smith has resigned from the board of Mobil Oil Company Ltd. due to increased duties in the Powell Duffryn Group and elsewhere.

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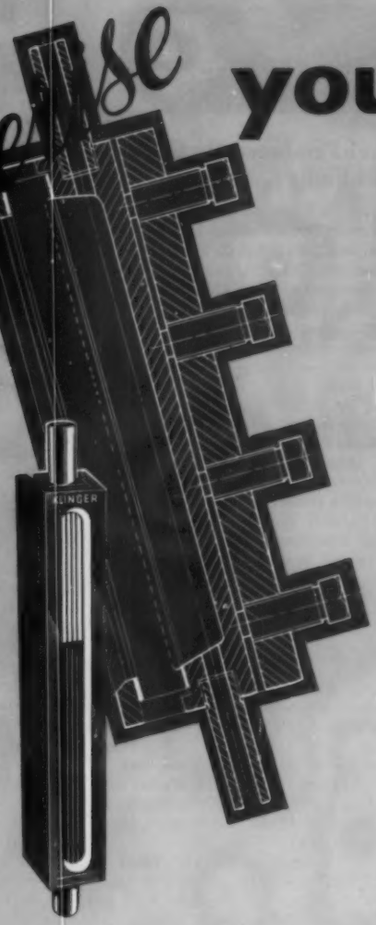

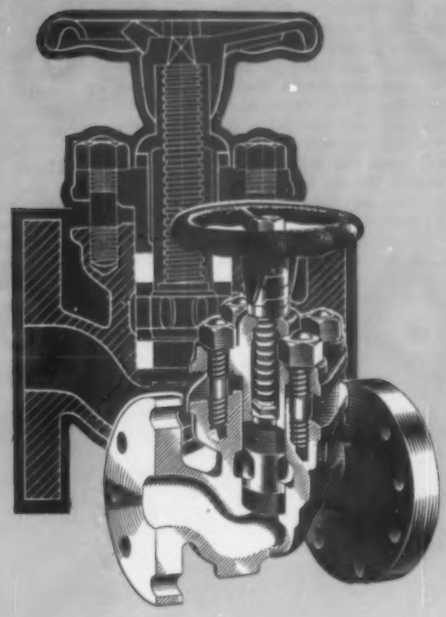

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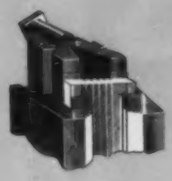

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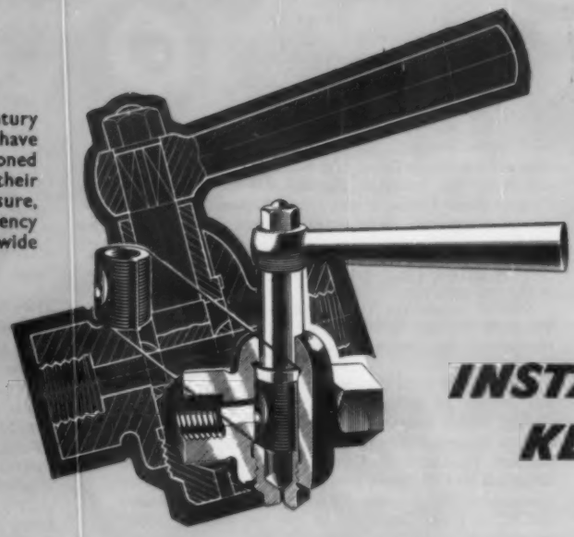

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International News and Notes

To Start New Pakistan Gas Line

A 200-miles, 16-inch pipe line in Pakistan is to be started about September of this year to deliver natural gas from the Sui field northward to Multan where a new power plant is being constructed. Decision to lay the line was made by government officials, after a recommendation from C. Stribling Snodgrass and others. Mr. Snodgrass is consultant on the gas project, and also on a line just completed from the Sui gas fields to Karachi.

The line will cross the Indus river at the Gudu barrage just east of the gas field, and then go north, parallel to the river through Uch, across the Sutlej river and on to Multan. The distance is 196 miles, not including river crossing. The crossing of the Indus river will be with a 6-inch pipe, later to be replaced by larger pipe. The 6-inch pipe will allow a capacity of about 50 million cubic feet daily delivered at Multan. Lahore and Lyallpur will be served when the permanent 16-inch pipe later is laid across the barrage, and extensions carried to these areas.

Gas reserves of the Sui field are estimated at four trillion cubic feet, of which 1.2 trillion cubic feet has been dedicated to the Sui-Karachi line. Estimated cost in thousands of rupees is 16,500 in internal expenditures, and 39,500 in external outlays.

A total of 172 supervisory persons will be needed for construction, of which 142 will be found locally, and 30 from abroad; some 366 craftsmen will be needed, 320 locally and 46 from abroad; 167 administrator of which 133 will come from Pakistan, and 34 from abroad; and 1,100 laborers, all Pakistan. Pakistan Industrial Development Corp. will handle the financing.

Wildcat In Libya

Libyan-American Co., plans to spud in its first well in Libya on April 1. The site is in the Cyrencican Jebel, 30 miles south of Barce, near Gerdes el Abid.

The company, a subsidiary of Texas Gulf Producing Co. Houston, Texas, is drilling quickly in return for concessions from the government covering the most promising geological structures, it is understood. Other companies in Libya are going in for extensive seismic and gravity surveys before they drill.

Delta Drilling Co., Dallas, Texas, has been lined up to drill the well. Equipment is due in late March. Fifteen Americans are helping with the work. The well site was chosen from the air by Howard H. Lester, geologist for Texas Gulf. The site was confirmed by ground survey.

Eight oil companies were licensed for oil development by the government. Companies bidding to do the seismic and gravity surveys include: General Geophysical Co., Geophysical Servicing Co., Seismograph Services Co. and Robert H. Ray Co. General is bidding on work for American Overseas (Caltex), Conorado group, Mobil and Esso.

Sumatran Fields Retained

Government officials continue to knock down reports that the Northern Sumatran oil fields will be returned to Bataafsche Petroleum Mij. Government officials and politicians assert under present operation, oil production is "going well" from three fields, Rantan, Pulau Tabuan and Djulurajev Atjeh. They say production is totalling 650 tons monthly, and could be increased if machinery with larger capacity were installed.

New Type Of Plastic Tank

A new type of plastic tank fitted on to a Leyland Comet "90" chassis has recently been brought into service by Shell in Sweden. The cabin on the chassis is also of plastic manufacture. The plastic material used is a cold-setting polyester resin in combination with glass-fibre cloth and chopped glass straw mat. It is said to be practically as strong as steel, with a specific gravity of 1.7° against 7.7° for steel, enabling —with the same axle load of 6,000 kilos maximum— an extra 10 percent of payload to be carried.

Millionth Barrel Produced By Gulf In Sicily

Gulf Italia Co., which is affiliated in Sicily with Gulf Oil Corp., has recently announced that the millionth barrel of oil was produced in Sicily from Gulf's Ragusa concession. Sicily has autonomous status under Italian law and during 1952 passed a liberal oil law which is in distinct contrast with that of the Italian mainland. The law was contested by the Italian government but upheld by the Supreme Court.

Most of the area of Sicily is now covered by exploration concessions or applications. Concession maps, which are available through *World Petroleum*, show Gulf's Ragusa concession as the only exploitation right, however. Other news from Sicily has concerned Gulf's plans to build a pipeline during early 1956 to the Augusta refinery. To date the oil has been transported by rail. The Augusta refinery is owned by RASIOM and operates its 35,000 b/d capacity, soon to be raised to about 43,000 b/d, on Middle Eastern crude at present. RASIOM is a partner with Standard Oil (New Jersey) in Sicilian oil exploration.

Pipe Line Bids Sought

U.S. pipe line contractors are asked to bid on a $757,626 oil pipe line laying job in the Netherlands, it is announced by the U. S. Department of Commerce.

They are also asked to bid on supplying the line pipe. The bids should be submitted to the Netherlands Government office with a copy to the Commercial Intelligence Division, U. S. Department of Commerce, for prompt certification.

Sought is 56 kilometers of 8-inch pipe with plain ends, of which 55 kilometers should have a wall thickness of 0.277 and one kilometer a wall of 0.375 for a river crossing. The estimated cost is $316,342.

A bid also is sought on coating and laying of the pipe line, including construction of valve pits, cathodic protection, and a river crossing at estimated cost of $441,285, and supply of nine valves, at an estimated cost of $810.

Exploration Report

A report covering progress in petroleum exploration on the Ivory Coast and Senegal has been published by the Director, Service des Mines, Dakar, French West Africa, it was learned. Several American oil companies have expressed interest.

Caltex (Egypt) Name Change

Société California Texas des Petroles, S.A.E., an Egyptian marketing affiliate of the Caltex Group of companies, has changed its name to Caltex (Egypt) S.A.E.

The change is in line with a policy of standardizing names of different companies of the Caltex Group, which consists of 94 companies doing business in the petroleum industry in 67 countries of the Eastern Hemisphere. Caltex (Egypt) S.A.E. with headquarters in Cairo, fills the entire petroleum requirements of Societe Egyptienne des Petroles—S.E.P., a large supplier of oil to the Egyptian economy.

Concession In New Guinea

Netherlands New Guinea Petroleum Co. has signed agreements expanding its concessions to almost the whole of Netherlands New Guinea except the mountain areas, it is reported. The government is sponsoring legislation to ratify the agreement. The company has been active in the area since 1935, and has found oil in only three places. The company has invested 362 million florin, (about $90.5 million) and oil production is valued at 70.4 million florin (about $19.8 million). NNGPM is a subsidiary of Bataafsche Petroleum Maatschappi, with 40%; Standard Vacuum Oil Co., with 40%; and Far Pacific Investors, 20%.

Rotary Rigs Around The World

The number of rotary rigs drilling in the world outside the Soviet orbit increased by about 10% at the end of 1955, compared with the beginning of the year. Large increases in drilling activity were shown in Latin America and in Asia. One area, Africa, showed a decrease but this was due to lack of figures on the area and generally exploration activity there increased as regards to entry of new companies and increased party activity, excluding drilling. A breakdown by country is as follows:

Country	Feb. 1955	Jan. 1956
North America:		
United States	2,465	2,829
Canada	205	194
Total	2,670	3,023
Latin America:		
Argentina	48	48
Bolivia	7	4
Brazil	9	24
Chile	5	5
Colombia	19	21
Costa Rica	1	1
Cuba	6	9
Ecuador	7	9
Mexico	75	76
Peru	18	21
Trinidad	28	30
Uruguay	0	1
Venezuela	104	118
(Eastern & Central)	(53)	(69)
(Western)	(51)	(49)
Total	327	327
Europe:		
British Isles	6	6
France	26	27
Western Germany	127	106
Italy	30	42
Netherlands	6	8
Portugal	2	2
Spain	3	3
Sicily	0	2
Total	200	196
Africa:		
Algeria	9	7
Egypt	5	N.A.
Angola	1	1
Ethiopia	1	1
Madagascar	1	1
Fr. Equatorial Africa	3	3
French Moroco	9	9
Nigeria	6	5
Tunisia	6	8
Mozambique	1	1
Total	42	36
Middle East and Eastern Mediterranean:		
Bahrain	1	1
Greece	1	3
Iran	4	3
Iraq	12	13
Israel	4	5
Kuwait	5	5
Neutral Zone	3	N.A.
Trucial Coast	1	1
Qatar	3	N.A.
Saudi Arabia	4	7
Turkey	5	5
Total	43	43
Other Asia:		
Australia	9	15
Burma	2	N.A.
Indonesia & Br. Borneo	32	54
India	6	12
Pakistan	5	5
Japan	15	15
New Guinea	4	4
New Caledonia	1	N.A.
Total	74	105
WORLD TOTAL	3,356	3,770

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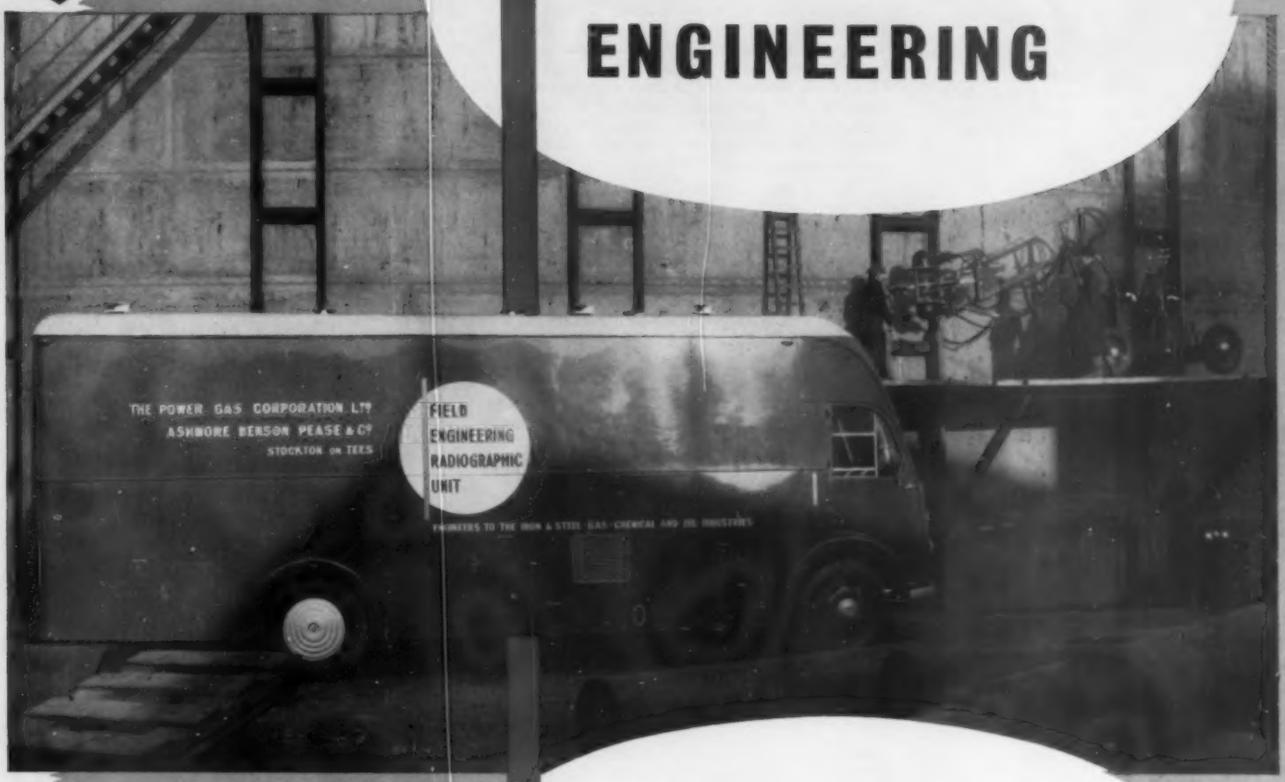
LEADERS IN FIELD ENGINEERING

Radiographic inspection of Welds on the 3,000,000 cu. ft. all-welded Gasholder at Stockton-on-Tees, built by Ashmore, Benson, Pease & Co.



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Turbo Drilling In Baku

According to Amirov, the chief of the technical administration of the Azerbaijan Ministry of Petroleum Industry, turbine drilling on the Baku oil fields was 15% higher in 1955 than in the previous year and drilling speeds were increased by 15 to 20% in 1955 against 1954. Amirov stated that at present 58 strata are being artificially treated with 2,471,700 cubic feet of water and about 15,889,500 cubic feet of compressed air being pumped daily into the wells.

Secondary recovery methods at about 3,000 wells raised production during the first 11 months of 1955 to more than 1,600,000 metric tons. Amirov said that the hydraulic breaking up of strata was first tried out in the Baku oil fields in the middle of 1954 and resulted in a 200 to 300% increase in well productivity. The Azerbaijan Scientific Research Institute has designed an equipment for hydraulic breaking of strata which is now being tested, capable of developing a pressure of 320 atmospheres, according to the government.

Amirov said that about one-third of the Baku oil workers are occupied with well repairs. Output of offshore fields has increased 2.5 times between 1950 and 1955. Oil extraction cost was reduced by 2.5% and oil refining cost was 0.5% below planned figures.

Japanese Crude Production To Be Developed By Private-Public Corporation

Formation of a joint government-private company to develop Japanese petroleum has been announced. The company will have about $2.8 million capital and will be a joint effort of Teikoku Oil Co., which has the large majority of Japanese crude production at present, and the government. About 78 percent of Teikoku's properties are under the new setup.

Negotiations with Russia are being carried forward. Japanese firms are discussing plans to import about 700,000 barrels of Baku crude from Russia, subject to exchange allocations from the government. Russia has reportedly offered to barter about 95,000 barrels, part of the payment to be in repair of Russian ships in Japanese yards.

Refinery In India

An Indian firm has proposed a crude oil refinery to be located at Bhaunagar in Saurashtra state. Iranian crude oil, from the Iranian Oil Co., would be used. French designers and builders would do the construction.

The state has endorsed the project, but wants to study it further before deciding yes or no. G. D. Rirla, Indian industrialist and H. C. Dinshaw are among the leaders in the venture.

Refinery Construction In Indonesia

A 11,100 b/d fluid catalytic cracking plant, a catalytic polymerization unit and other improvements for its Sungei Gerong refinery near Palembang, Indonesia are planned by Standard-Vacuum Oil Co. The refinery modernization projects, estimated to cost $20 million are part of Stanvac's four-year $80 million capital investment program in Indonesia announced last year.

Italy's First Platformer

The first platforming unit in Italy was commissioned in January at Porto Marghera refinery, Venice, which is jointly owned by The British Petroleum Co. and Azienda Generale Italiana Petroli. It will have a capacity of 2,000 b/d and will produce a high grade gasoline component by a reforming process, using a platinum catalyst. This will be the seventh platforming unit to be built for refineries of the B.P. group.

Deepest Well In India

Well No. 12 at Naoholia, in the Hugrijan oil prospecting license area of Upper Assam, set a new depth record in India at present depth of 11,855 feet. If it goes beyond 12,666 feet (the depth of Lakhra No. 1, in Sind, Pakistan) it will become the deepest well ever drilled in Asia.

Austrian Gas Reserves

The natural gas reserves of the newly discovered gas field at Zwerndorf (Lower Austria province) are estimated at 529,650 to 882,750 mmcf. This amount would suffice to supply Vienna's gas and electricity works for 50 years, according to Professor Kurt Peters, dean of the Vienna Polytechnicum. Professor Peters demanded a more economic use of Austria's gas reserves, since several oil fields are flaring a total of 21,186,000 to 35,310,000 cubic feet of gas per day.

He pointed out that the relatively small share (6.34%) which natural gas occupies among Austria's energy sources could be enlarged considerably by utilizing the hitherto wasted portion of natural gas.

Rumanian Pipe Manufacture

Rumania claims to be building one of the most modern pipe rolling mills in the world. It is to supply the domestic oil and gas industry and also foreign markets with pipe up to 16-inch in diameter. Production is scheduled to start within the next five years. Yearly maximum output of 16-inch pipe is estimated in Rumania to reach 2,173 miles. The factory is being built on Soviet blueprints and will cover an area of about 14 acres.

Responsible For Medical And Health Services

The National Iranian Oil Co. in January took over from the Consortium's two operating companies in Iran, the first of the non basic operations for which they will gradually assume responsibility under the 1954 oil agreement. The operations for which NIOC have become responsible are the medical and health services in the oil areas of south Iran.

Mafia Wildcat Completed

A test well on Mafia Island, off the coast of Tanganyika, by the D'Arcy Shell Petroleum Development Co. of Tanganyika (a joint enterprise of The British Petroleum Co. and the Royal Dutch Shell Group) has been abandoned. The well was drilled to 11,051 feet. Valuable geological information was obtained according to the company, but no oil or gas shows were reported. The equipment will shortly be transferred to Zanzibar where a second test will be drilled.

To Increase Hungarian Production

Hungary plans to increase its crude oil output in 1956 by 6.6% compared with 1955. The number of wildcats is to be increased by 40%. 1956 crude oil output is scheduled to reach 1,770,000 metric tons (35,400 b/d).

Gas Show In Papua

Australasian Petroleum Co. has discovered substantial gas at 998 feet in Kuru No. 1 in Papua. The gas is escaping behind casing recently cemented in at 449 feet.

Polish Supply And Demand

Poland covers about 25% of her oil requirements from domestic sources. Yearly oil demand is about 1,500,000 metric tons (30,000 b/d). Crude production in 1955 is estimated at 394,000 metric tons (7,800 b/d). Exploration work now reportedly is centered near the area of Jaslo (75 miles southeast of Krakow).

Austria Oil To USSR

The Institute of Economic Research in Vienna reported that during the 10-year occupation of Austria, petroleum and its derivatives to the value of about 1,000 million Austrian Shillings ($38,461,538) were shipped out by the Soviets from their occupation zone without compensation to Austria. The Institute based its figures on statistics of the Austrian Federal Railways, the only institution that was in a position to register the number of trainloads that left Austria for behind the Iron Curtain.

Oil Use Gaining In Germany

On the basis of a questionnaire by the Munich Economic Research Institute, the use of fuel oil in Germany is growing relative to coal. Total fuel use remains small to date, however. Replies indicated that 11% of firms questioned intend to replace coal installations by oil burners during the first half of 1956. This compares with five percent during the last half of 1955. The use of fuel oil accounted for less than three percent of industrial power during 1954, according to the Institute, but by the third quarter of 1955 this had gone up to just under four percent. Industries tending toward fuel oil use include paper manufacture, automobile and machine industries, garment, shoe and leather industries.

Italian Product Exports Decline

Exports of petroleum products from Italy declined during 1955, based on the first 10 months' figures, except for gas and Diesel oils which showed a slight increase. Figures are as follows:

(Thousand of Metric Tons)

	1954	*1955*
Gasoline	1,515	1,419
Kerosine	479	356
Gas & Diesel Oil	1,291	1,344
Res. Fuel	1,963	1,660

Arbitration For Iraq

The Iraq Government and the Iraq Petroleum Co. Ltd. have failed to agree about Iraq's demand for further royalties, in respect of oil produced in 1953. Iraq, has decided to go to arbitration in the matter.

French Oil Exploration

Oil exploration licenses in the Isere Department of France, on the western edge of the Alps, have been granted to a newly formed company, Societe des Petroles de Valence. British Petroleum Co. has a 30% interest through its prospecting subsidiary, D'Arcy Exploration Co. A further 20% of the new company's capital is held by BP's French associate, Societe Francaise des Petroles BP. Other interests are held by the State institution Bureau des Recherches de Petrole, two oil investment companies and a regional oil distributing company.

Yugoslavian Imports

Rich oil deposits, recently discovered at Lendava (Slovania Province) and at Mramor Brdo, Ivanic Klostar, and Jermenovci (along the Croatian-Hungarian-Rumanian border) will increase Yugoslavia's oil production, according to the Government. Production now is 270,000 metric tons per year (about 5,400 b/d). Yugoslavia is reported to have spent 2,700 million Dinars (9,000,000) last year for crude oil imports.

Exploration Difficulties In Libya

A number of American petroleum companies, recently given the green light to explore for petroleum in Libya, are facing the hazards of land and sea mines left over from the last war. They are scurrying around for maps of the country. U. S. Military authorities have maps, but they hesitate to give them out without the permission of the foreign country. In this case, Libyan officials are agreeable as they want the oil found, but there still is red tape.

Eight Concessions To Stanvac

Eight oil exploration concessions in the Cagayan Valley of Northern Luzon totaling 388,350 hectares (approximately 966,000 acres) have been granted by the Philippines Government to Standard-Vacuum Oil Co. The concessions are good for four years with the privilege of two 3-year extensions or a maximum of 10 years. In addition, one half of these areas may be converted to oil development concessions.

Pending the formal granting of the exploration concessions, Standard-Vacuum sent a geological team to the Philippines in mid-October to study the surface formations in the valley.

Stanvac also has plans for the construction of a 21,000-barrel refinery in the Philippines. Headed by Joseph A. Parrish, Stanvac's regional coordinator for the Far East and a former general manager of the company's Philippines marketing division, a team of negotiators has been in Manila for several weeks discussing the project with the National Economic Council.

Stirling Moss takes first place, in the fastest R.A.C. T.T. of all time. Fangio and von Tripps took second and third. Each drove a Mercedes 300SLR—using BP Super.

BP SETS THE PACE

THE TRACK and the test-bed are BP proving grounds. On the roads and race-tracks of Europe BP fuels and lubricants are consistently proving their worth in all types of races; in 1955 alone 12 of the world's major motor racing events were won on BP products.

At the BP Laboratories at Sunbury research never ceases. Motor, aviation and gas turbine fuels, vaporising oils, diesel oils and lubricants—all are constantly under test to ensure best quality.

The final gains go to millions of users all over the world. The proved performance of BP products is theirs to enjoy wherever they see the BP sign.

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Latin American Oil News

Oil Production in South America—1955

By Juan E. Rassmuss

South America's production increased during 1955 in Venezuela, Ecuador, Chile and Brazil. It remained stationary or declined in Colombia and Peru. On Argentina definite data is not yet available, but YPF shows an increase of about three percent.

In Venezuela output increased by 13.4% to 2,157,216 b/d. Production in December reached about 2.3 million b/d, of which Creole's production alone was over one million b/d.

Colombian crude output in 1955 was 39,383,767 barrels, about 107,900 b/d, slightly lower than 1954. Texas' Velasquez field, using the new pipe line to Galan, increased its production in the last months substantially to 20,000 b/d in November. In December 1955 Colombia's output reached a peak of 117,139 b/d derived from Shell with around 40,000 b/d, Empresa with around 31,000 b/d, Colombian Petroleum Co. (Socony-Texas) 24,600 b/d and Texas 20,600 b/d.

In Peru crude production during 1955 totaled 17,243,591 barrels or 47,242 b/d, 0.5% over 1954. International Petroleum Co. declined to 11,319,658 barrels, Petrolera Lobitos increased by about 3.5% to 4,964,099 barrels, Empresa Petrolera Fiscal's output was about the same with 592,384 barrels and Ganzo Azul decreased 17% to 262,413 barrels. Three new companies in the coastal area contributed for the first time. The national Petrolera Peruana produced 71,529 barrels; Peruvian Pacific Petroleum Co. produced 19,701 barrels; and Douglas Oil Co. of California, which has drilled eight offshore wells, produced 13,807 barrels from one producing well.

Ecuador's production is estimated at 3.5 million barrels, an increase of about 13%. For the first 10 months output exceeded 2.9 million barrels at a daily rate of about 10,000 b/d in the last months.

Chile's production increased during 1955 by 48% from 1,736,242 barrels in 1954 to 2,576,788 barrels or 7,060 b/d in 1955. This rise was due to augmented drilling, supervised by Santa Fe Drilling Co., and a higher number of completed wells. Fifty-eight wells were drilled in 1955 against 40 in the preceding year, 25 were producers in 1955, 11 more than in 1954. Output in the last months averaged about 8,500 b/d. It is expected soon to supply half the requirements of the new 20,000 b/d refinery at Concon.

In Bolivia output in 1955 is estimated at 2.7 million barrels or about 7,400 b/d compared with 1.7 million barrels in 1954, an increase of about 60%. Production for 11 months, according to YPFB was 2,461,518 barrels, daily average production in the last months was about 8,500 b/d. Production is curtailed by lack of sufficient outlets. Completion of the pipe line to La Paz will permit shipping of products to southern Peru. This plus the construction of the pipe line to Arica on the Pacific, and the enactment of the new liberal pertoleum law of Oct. 26, 1955 should speed up the development of Bolivia's oil resources.

In Brazil output of the Bahia fields increased from 992,000 barrels in 1954 to 2,021,000 barrels of 5,537 b/d in 1955.

In Argentina output of YPF increased in the first three quarters of 1955 to 69,700 b/d against 67,500 b/d in 1954. Adding about 13,000 b/d for the output of the private companies, total output can be estimated in about 83,000 b/d. According to recent statistics, imports amounted to about 130,000 b/d, raising Argentina's total demand to around 210,000 b/d.

At the year's end, large prospective areas remained undeveloped. New concessions in Venezuela, opening of the rich resources of Bolivia to private capital and exploration of Peru's Montana seem the most important new factors in South America's future development, which is of special importance to the free world's oil supply because of the dark clouds on the political horizon in the Middle East.

Oil Shows Reported In Costa Rica

Union Oil Co. officials disclosed that their Cocoles No. 1 well found traces of oil and gas at 3,729 feet. They describe the signs as "encouraging." However, they point out that they are continuing drilling and that subsequently no further traces have been found below 4,000 feet.

Union's subsidiary, Compania Petrolera de Costa Rica, S.A., has drilled four dry holes in Costa Rica to date and has spent an estimated $4 million dollars on their wildcat operations in Costa Rica. Cocoles No. 1, approximately 35 kilometers from the Panama border, is their fifth well.

First reports of the traces of oil caused intense excitement in Costa Rica's capital of San Jose. However, Union officials urged caution in making any optimistic reports of their progress.

Depletion Allowances In Trinidad

Recent legislation grants depletion allowances for submarine production, subject to the proviso that the search for oil on land must not be slowed down. Designated "Submarine Well Allowance," this concession provides for relief on taxable income as follows: 1956-1960, 10%; 1961-1965, 15%; 1966-1982, 20%.

According to the terms of the law, these benefits are receivable by any company engaged in submarine drilling for oil or gas. They were proposed, said the bill, in view of the extraordinary hazards incidental to submarine drilling, and the heavy expenditure involved. They do not, however, apply to marine wells drilled from the land by deviation. The bill was presented on Dec. 23, 1955. It amends the Income Tax (In Aid of Industry) Ordinance.

Deciding against equating the allowance to the 27½% prevailing in the United States of America, or along the lines of that obtained in Canada, the Trinidad Government has conditioned: (1) that the allowances come under review after a suitable duration; (2) that land exploration shall not be slowed down or prejudiced by concessions given for marine exploration; (3) that in the case of operations likely to show an early profit, the incentive be less than for those of a long-term character; (4) and that the concessions be granted only to locally registered companies.

The cost, said Mr. Blache-Fraser, government financial secretary, of the Trinidad Northern Areas marine well begun in July, 1954 (since completed successfully) off Point Fortin was five times greater than the cost of a well of similar depth.

Guatemalan Concession Allocations Due In March

The overlapping concession applications in Guatemala held by some 29 companies (WORLD PETROLEUM, January 1956), are not expected to be completely resolved until during March, in the opinion of oil company officials in Guatemala. A review of applicants' qualifications is beginning at present which may disqualify some. A second step is for the remaining applicants to attempt to resolve the problem of overlapping applications for specific areas in the Peten between themselves. While the law does not specifically provide for the revision of existing applications, it is tacitly understood that this will be permitted if there is any indication that some intercompany agreement can be reached on the problem.

If all fails, the Guatemalan Government will put up specific areas in dispute for bid to the highest bidders. However, officials state that Guatemala is not interested in "making money on an auction" and is more interested in having the various oil companies start exploration and drilling at the earliest possible moment.

Practically the entire territory of the Province of Peten is involved, plus a substantial section of territory in an area almost surrounding Lake Izabal. The latter lake has an entrance to the Caribbean Sea. The Province of Peten, however, is a remote northern section of Guatemala and oil company officials expect to fly in their equipment. Some exploration equipment is already arriving at Guatemala sea ports.

Venezuelan Runs & Exports

Venezuelan petroleum refineries had a throughput of nearly 195,000,000 barrels of crude during 1955, according to reports reaching official Washington channels.

Firm figures show a throughput of 16,664,000 barrels for October and of 162,522,000 for the first 10 months of the year. The throughput is of crude, slops and product intake for blending. Here are the figures on finished products:

Jan. 1-Oct. 31, 1955
(Barrels)

Throughput

Finished Products	
Aviation gasoline	—0—
Motor fuel & spec. naphtha	21,827,000*
Kerosine	6,073,000
Gas oil & Diesel oil	33,457,000
Fuel oil	94,041,000
Narrow cut lube dist.	599,000
Finished lube oils	806,000
Slach wax	171,000
Asphalt	1,003,000
Still gas, burned as fuel	2,132,000
Slops	305,000
Stripped crude	1,311,000
Wax distillate	94,000
Miscellaneous, including unfinished products	561,000
Lesser	142,000
Totals	162,522,000

Exports

Crude Exports to 22 countries	
Aruba	141,216,149
U.S.A.	116,273,418
Curacao	86,240,234
Canada	56,014,803
British West Indies	14,000,093
Netherlands	16,201,625
Brazil	13,997,350**
Argentina	11,396,017
United Kingdom	10,916,439
Uruguay	4,264,299
Italy	3,755,167
France	3,142,598
Canary Islands	2,568,200
Chile	1,821,317
Puerto Rico	1,723,907
Germany	2,597,461
Belgium	1,167,229
Sweden	873,159
Norway	560,722
Israel	464,246
Australia	271,722
Cuba	137,015
Total	489,576,224

Product Exports	
Fuel Oil	75,680,024
Diesel oil	17,286,536
Gas oil	10,932,100
Gasoline	8,939,398
Kerosine	3,432,020
Lube oils	781,734
Asphalt	218,764
Other	2,024,085
Total	119,294,661

Products went to 50 countries including:	
U.S.A.	47,177,384
Brazil	11,482,422
Curacao	10,924,541
United Kingdom	9,859,996
Sweden	5,300,245

Production

Crude production	648,564,415
Natural gasoline production	896,571
Butane production	598,984

* Includes 194,233 barrels of white hydroformate; 44,655 barrels of light hydroformate, 33,985 barrels of heavy hydroformate; 187,020 barrels of aviation hydroformate.

** Includes 2,884,826 barrels of naphtha and other derivatives added to crude.

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Latin A

Oil Production
South America—

By Juan E. Rassi

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Bit for bit, regular or jet, you will find that *consistently*—day-after-day—you get faster penetration and more hole per bit with Hughes bits. The superior performance of Hughes bits has been proved in hundreds of thousands of wells—not just a hand-picked few—and in the drilling of more than a billion feet of hole throughout the world. HUGHES bits enable you to get your well down in the shortest possible time... and to take *full* advantage of new drilling techniques.

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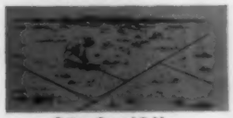

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Canadian Notes

Appointed Public Relations Manager

Francis J. Himbury has been appointed manager of public relations of Canadian Oil Companies, Ltd. He has been with the company since 1939 and prior to his new appointment was assistant to the president.

Reformer Contract Let

A contract for the construction of an 8,000 barrels daily catalytic reformer at the Montreal refinery of Imperial Oil Ltd., has been awarded to Fluor Corp. of Canada Ltd. The new unit is the main item in a $4,500,000 program of refinery improvement at Montreal. The work is part of Imperial's programed 1956 expenditures of $115,000,000. Construction will begin by mid-summer and is expected to be completed by early 1957. The platinum catalyst unit will be similar to one now under construction at Imperial's Sarnia refinery.

British American Dividend

A dividend of 21¼ cents per share for the first quarter ending March 31st, 1956 (at the rate of 85 cents per share per annum), has been declared on the issued no par value common stock, payable in Canadian funds, April 2nd, 1956 to shareholders of record at the close of business on March 2, 1956.

To Head New BP Offices

T. G. McLintock will head new offices of British Petroleum (Canada) Ltd. in Montreal. He has been a member of BP's staff since 1946.

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MONTREAL WINNIPEG VANCOUVER VICTORIA
CALGARY LONDON OTTAWA KITCHENER HAMILTON
ST. CATHARINES OWEN SOUND QUEBEC LONDON, ENG.

W. O. Twaits

J. A. Cogan

A. E. Osborough

J. W. Morgan

Imperial Oil Appointments

W. O. Twaits has been appointed executive vice president of Imperial Oil Ltd. and J. A. Cogan has been named a director of the company, following the retirement of G. L. Stewart who had been chairman of Imperial's board.

Mr. Twaits joined Imperial in 1933. He became a director of the company in 1950 and has been a vice president since 1952.

Mr. Cogan joined Imperial in 1952 as an assistant manager of the manufacturing department after extensive experience with Standard Oil Co. (N.J.) in the United States.

Mr. Stewart retires from Imperial after 39 years with the company, 11 of them as a member of the board of directors. He was president from 1949 to 1953, and served twice as chairman of the board; from 1947 to 1949 and again from 1953 until his retirement.

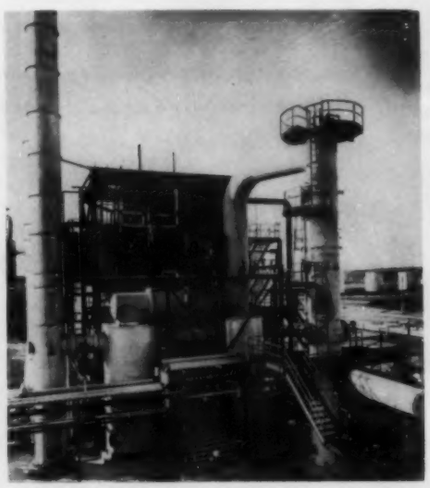
To Build Pump Station

Trans Mountain Oil Pipe Line Co. will build an $800,000 pump station at Laurel, Wash., to serve Shell Oil Co. and General Petroleum Corp. refineries in the Puget Sound area. Pumps at the station will be electric motor driven.

Trans Mountain has a 20-inch spur line to Laurel from which 16-inch delivery lines have been laid to the two refineries which are running Canadian crude. The Trans Mountain line now is pumping 110,000 b/d which is nearly twice the rate maintained a year earlier.

Alkylate Plant In Canada

A $3.8 million plant to make the ingredient known as detergent alkylate will be built at the Imperial Oil Ltd. refinery in Sarnia. The plant will be the first in Canada and Imperial's first step into the petrochemical field since its chemical products department was set up late last year. The plant will be completed around mid-1957. Its output will displace an annual import of about $2½ million worth of detergent alkylate.



Further reducing air pollution in Ontario's "Chemical Valley" at Sarnia, this carbon monoxide boiler recently set in operation at the Sarnia refinery of Canadian Oil Companies, Ltd., effectively combines production of steam from waste heat and combustible gases with an "appreciable" reduction of air pollution, company engineers said. It also was designed to supply the additional steam required for increasing the refinery's capacity to process 30,000 barrels of crude oil per day.

New B-A Appointments

J. W. Morgan has been named general manager of manufacturing and A. E. Osborough general manager of marketing for The British American Oil Company.

Mr. Morgan joined B-A refining operations at the Calgary refinery in 1939 and has been assistant manager of manufacturing at the head office for the past two years. Mr. Osborough joined B-A in Vancouver in 1945 and was most recently the company's regional manager for Ontario.

Imperial Oil Net Up 25.2%

After provision for income tax, consolidated net earnings of Imperial Oil Ltd. for 1955 are estimated at $62,100,000 or approximately $2.08 per share by preliminary estimate. A record year for the Canadian economy brought about an increase of 15% in the volume of petroleum products sold by the company and an increase of nearly 12% in net crude production of Imperial's crude oil.

Pipe Line Extension Not Confirmed

Interprovincial Pipeline Co. calls "unauthorized and premature" reports that it may extend its oil pipe line another 160 miles from Sarnia to Port Credit, Canada.

According to reports, widely circulated, the company would start the extension in 1957; the cost would be $10 to $13.5 million. The line would supply refineries of British American Oil Co., at Clarkson; Regent Refineries Ltd., Port Credit; and one at Bronte, which Shell would build. Clarkson, Port Credit and Bronte are near Toronto.

Shell Oil Co. of Canada has no plans to construct a petroleum refinery at Bronte, Ont., Canada in the foreseeable future, it says. It only bought a 600-acre site there to protect itself against increase in real estate prices in the event it might want to erect a refinery in the future.

J. L. Lenker

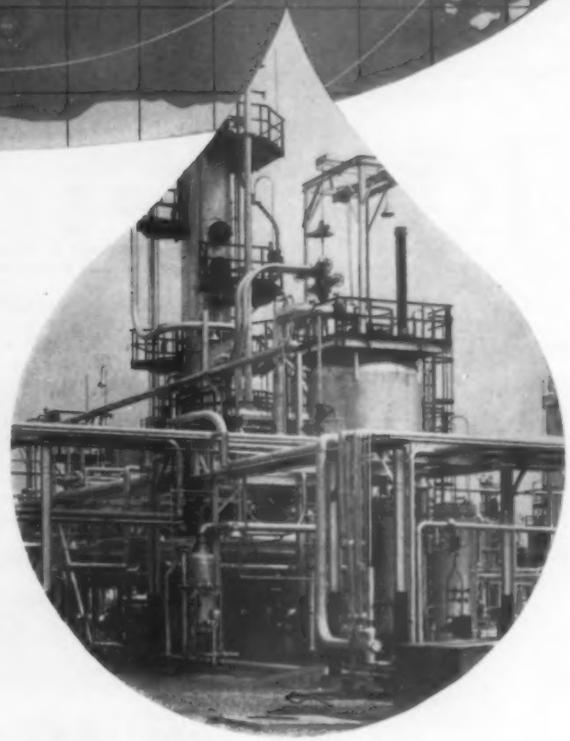
Appointed BA Vice President

J. L. Lenker, general manager of retail and jobber sales in the domestic marketing department of Gulf Oil Corp., has been appointed vice-president, marketing of the British American Oil Co., with headquarters in Toronto.

Throughout the World

SPENCE

Spence cobalt and molybdenum oxides on alumina catalyst is a sulphur resistant hydrogenation catalyst which is being used in increasing quantities at refineries throughout the world. It is a robust catalyst of high activity, proven by years of service on a commercial scale



Hydrofining unit, Esso refinery, Fawley. This is one of the many plants using Spence catalyst. Photo by courtesy of Esso Petroleum Company.

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Oil Company Staff Changes

WILLIAM W. HULIN, superintendent of the Baltimore refinery of The American Oil Co. has retired after more than 35 years' service with the company. He joined the company in 1920 as an assistant in the manufacturing department at Destrehan, La., and was named superintendent of the Baltimore refinery in 1925.

WALTER L. KEEFE has been appointed petroleum and natural gas engineer in charge of foreign petroleum production activities in the Office of Oil and Gas, Dept. of the Interior.

JOSEPH BOWES has been elected chairman of the board and H. A. Eddins president of Oklahoma Natural Gas Co. Mr. Bowes had been president of Oklahoma Natural since 1936 and will continue as principal executive officer.

A. C. FISCHOFER has been elected a vice president and director of Tropical Gas Company, Inc., Miami, Florida. He formerly was executive vice president and a director of Esso Standard Oil, S. A., from which he has retired after more than 30 years of service with domestic and foreign affiliates of Jersey Standard. In his last position he was concerned with marketing, refining, and exploration, in the Caribbean area and Central America, with headquarters in Havana, Cuba. Tropical Gas Co. with its international headquarters in Miami Florida, now operates in 16 foreign countries.

JOHN A. CORRIGAN has been appointed district sales manager of Sinclair Chemicals, Inc., subsidiary of Sinclair Oil Corp. Mr. Corrigan, who had previously been Sinclair Chemicals sales representative in Chicago, will manage the company's chemical marketing activities in the Midwest with headquarters in Chicago.

G. L. BRENNAN, a vice president of Warren Petroleum Corp., has been elected a director, succeeding Howard E. Felt.

CONGER REYNOLDS, director of public relations for Standard Oil Co. (Ind.) for 26 years, retired February 1 to become chief of the Office of Private Co-operation of the United States Information Agency in Washington. Mr. Reynolds was succeeded as head of Standard's public relations department by Don Campbell formerly assistant director. James M. Paterson became director of field services; John Canning became director of information services; and Robert Siebert became editorial director.

Conger Reynolds

WARREN THOMPSON, assistant director of the research and development department of D-X Sunray Oil Co., has been named manager of the company's research and technical service division, as one of six major company promotions. L. D. Stewart, assistant general refinery superintendent for the West Tulsa plant, has been named assistant manager of the division. J. A. Middleton, assistant general refinery superintendent, mechanical, at West Tulsa, has been appointed manager of the engineering construction and maintenance division. Gayle Rodgers, who was manager of the technical service department for Sunray Oil Corp. before the merger in 1955, has been named administrative assistant to G. E. Wynn, vice president, manufacturing.

Pierce Reynolds, chief process engineer, has been promoted to second assistant superintendent of the operating department of the West Tulsa plant. Carl E. Larson has been promoted to superintendent of lube in the heavy oil department at West Tulsa.

PAUL D. BARTON has been appointed director of engineering for Sun Oil Co. George M. Closs is now associate director of engineering.

J. E. BIXBY has been appointed assistant treasurer of Texas Eastern Transmission Corporation.

FRANCIS H. SMITH, general manager of operations in the manufacturing department of Standard Oil Co. of Calif., has retired after 43 years of service. He will be succeeded by J. T. Higgins who has been serving as president of Standard's subsidiaries, the Salt Lake Refining and Salt Lake Pipe Line companies, in Salt Lake City.

Mr. Smith joined the company in 1913, as a blueprint boy at the El Segundo refinery. In the next 15 years he rose to superintendent at the Richmond refinery and, in 1933 to manager. In 1944 he became assistant general manager of manufacturing department and manager of operations the following year.

Mr. Higgins has been with Standard since 1929. He joined the company following his graduation from Stanford University and served as a specialist and foreman at El Segundo until 1937. He had held supervisory and managerial posts at Richmond refinery and in the San Francisco home office. Prior to his assignment in Salt Lake City, he was manager of operations at Richmond.

WALTER S. HALLANAN, president of the Plymouth Oil Co., Pittsburgh, was re-elected chairman of the National Petroleum Council at its January meeting. R. G. Follis, chairman of the Standard Oil Co. of Calif., San Francisco was re-elected vice chairman.

SAMUEL H. WOODS has retired as division chief geologist of Sun Oil Co.'s Mid-Continent division, headquartered in Dallas, after 34 years of service with Sun. Ronald J. Cullen, another veteran Sun man, succeeds Mr. Woods as division chief geologist.

JAMES R. KEITH has replaced Carlton R. Barkhurst as general manager of The Bahrain Petroleum Co. Ltd. Mr. Keith has gone to Bahrain to take over the position. Mr. Barkhurst, assigned to Bahrain since 1937 when he reported there as a refinery technologist, will return to New York to assume new duties with the refining division of California Texas Oil Co. Ltd.

HENRY J. STRUTH, petroleum consultant, has established new headquarters at 911 Insuromedic Life Building, Dallas. Following the recent publication of *World Petroleum Report*, which he compiled and edited, Mr. Struth announced an expanded program of activities including international petroleum industry surveys, regional and national studies of oil and gas finding costs, government-industry relations, and a series of informational oil reports. He will serve also as economic advisor and consultant to various domestic and foreign clients.

George J. McLernon, Jr.

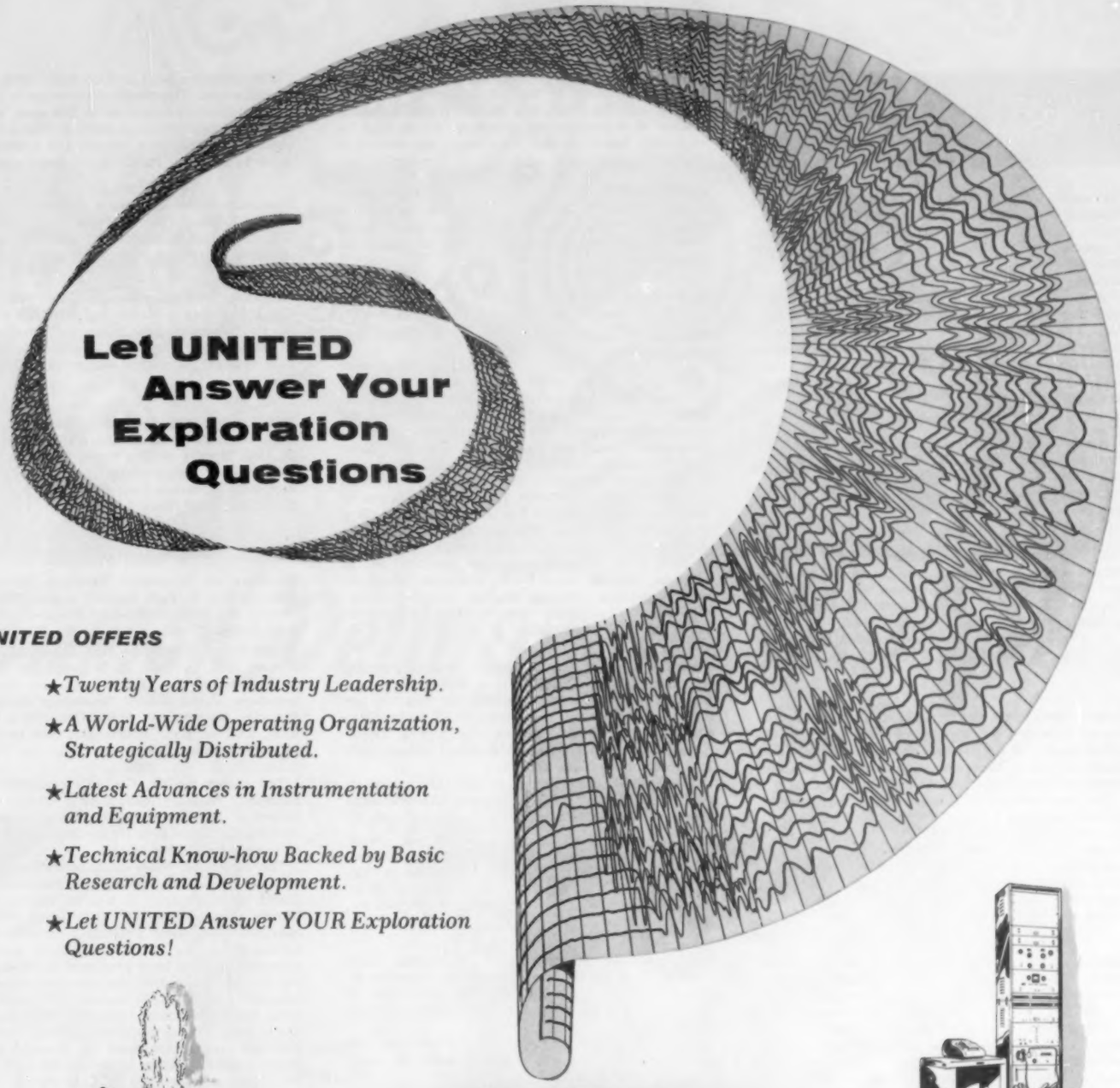
GEORGE J. McLERNON, JR., has been appointed manager of operations at Tulsa offices of APA, Inc., Minneapolis. Lyall Romick, Jr. was named office manager.

Mr. McLernon entered the petroleum industry in 1933 and was with Magnolia Petroleum Co. prior to his service in the U. S. Navy during World War II. For the past five years he has been chief engineer of Mid-States Oil Corp.

SERGE B. JURENEV has been promoted to assistant to the president and chief economist for Continental Oil Co. Formerly assistant to the chairman of the directors, he will continue to make his headquarters in New York. Mr. Jurenev joined Continental in New York in 1942 and two years later became secretary and assistant treasurer. He was promoted to secretary and treasurer in 1948. He assumed charge of the coordinating and planning department in 1949 and the following year transferred to the company's executive offices in Houston, Texas. He returned to New York in 1953 as assistant to the chairman.

R. REA JACKSON has been apointed general manager of the manufacturing department and chairman of the manufacturing committee of Socony Mobil Oil Co., Inc. Charles P. Baker succeeds him as director of manufacturing for Mobil Overseas Oil Co., Inc. Mr. Baker has been manager of Socony Mobil's domestic refining operations and vice chairman of its manufacturing committee.

R. Rea Jackson



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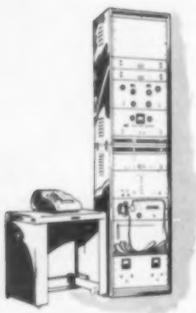

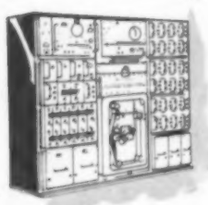

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New Publications

CANADIAN OIL AND GAS, by David E. Lewis and Andrew R. Thompson. Butterworth and Co. (Canada) Ltd., 1367 Danforth Ave., Toronto, Ont., Canada, 1955. (In the U.S.: Matthew Bender and Co., 443 Fourth Ave., New York 16, N.Y.) $85, including one year's service.

A thorough study of Canadian oil and gas law and the laws of every province in Vols. 2 and 3. Vol. 1 contains legal review and comparison of federal and provincial law, with digest of cases; also forms and precedents. Volumes are in loose-leaf form and are maintained up to date by regular revision.

HYDRAULIC INSTITUTE-STANDARDS (10th Edition), by Hydraulic Institute, 122 E. 42nd St., New York 17, N.Y., 1955. $4.75, domestic; $5.25, foreign.

Covers centrifugal, rotary and reciprocating pumps. Has data section and is indexed.

THE MEXICAN PETROLEUM INDUSTRY, by J. Richard Powell. (Published through the Bureau of Business and Economic Research, Univ. of Calif., Los Angeles.) University of California Press, Berkeley 4, Calif., 1955. $4.

A review of the Mexican oil situation from early days through 1950. Covers all phases in a thorough way.

ENERGY PRODUCTION AND UTILIZATION IN LATIN AMERICA—A Summary of the Preliminary Report on the Development of, by United Nations Economic and Social Council, Economic Commission for Latin America, Sixth Session, Bogota, Colombia, 1955.

This is a synopsis of a much larger report which is being prepared for publication. It discusses energy production and utilization in Latin America as a whole and defines petroleum's place therein. Uses are projected to 1965 and petroleum's advance is discussed on a country basis. Length is 86 pages, double-spaced. Report designation is E/CN.12/373/Rev. 1. Written in English.

DETERMINATION OF SHEAR STABILITY OF NON-NEWTONIAN LIQUIDS (Special Tech. Publication #182). American Society for Testing Materials, 1916 Race St., Phila. 3, Pa., 1955. Bound in heavy paper, 75¢.

This publication will be of value to those concerned with development or use of polymer liquids and of mechanical devices in which those liquids are used. It describes several test procedures which are capable of giving comparable results and reports the data from a cooperative effort to develop a suitable test method for measuring shear stability of non-Newtonian liquids. The material of this report was prepared by N. D. Lawson of E. I. du Pont de Nemours, & Co., Inc. for Section B on Viscosity Methods—Non-Newtonian Liquids of Research Division VII on Flow Properties of ASTM Committee D-2 on Petroleum Products and Lubricants.

ASTM STANDARDS ON PLASTICS. American Society for Testing Materials, 1916 Race St., Phila. 3, Pa., 1955. $5.75 ($4.40 to members).

Specifications for and methods of testing plastics are contained in this new ASTM publication of nearly 800 pages.

HANDBOOK OF OIL AND GAS LAW, by Robert E. Sullivan. Prentice Hall, 70 Fifth Ave., New York 3, N.Y., 1955. $11.35.

This is a book which the author describes as for all persons interested in legal aspects of the oil and gas industry, whether lawyers or not. It is primarily devoted to production and transportation, especially the former. It begins with the rudiments of geology, carrying through the landowner's interest, the oil and gas lease, conservation, taxation and miscellaneous problems of the oil industry, including drilling and financing. The book is a much-needed review of a complicated situation, which may be especially handy at this time when the matter of regulation is so vital, especially in the natural gas industry. It is to be regretted that a list of citations of applicable laws and a specification of the requirements of federal and state legislation as such is apparently not contained in this handbook; however, for general use this is perhaps of minor importance.

FUEL: SOLID, LIQUID AND GASEOUS, by J. S. S. Brame and J. G. King. Edwin Arnold (Publishers) Ltd., London, 1955. (In the U.S.: St. Martin's Press Inc., 103 Park Ave., N.Y. 17, N.Y.) $10.

This book provides, at the level of the science graduate, a review of all the types of fuel now in common useage, including coal, petroleum, natural and manufactured gas and atomic or nuclear energy. The authors limit themselves strictly to the properties of fuels and the methods of their application without including details of the processes of production or methods of their application and with the intent only to provide a broad introduction to fuel technology. Within this limitation, they give one chapter to wood, peat and minor solid fuels; six chapters to coal in its various forms; one chapter to coke; three to liquid petroleum products; one to benzene, alcohol and their mixtures; three to various gaseous products; closing with three chapters on fuel analysis, determination of calorific value and fuel efficiency.

PEACEFUL USES OF ATOMIC ENERGY: Vol. 2—PHYSICS, RESEARCH REACTORS, $8; Vol. 3—POWER REACTORS, $7.50; Vol. 14—GENERAL ASPECTS OF THE USE OF RADIOACTIVE ISOTOPES: DOSIMETRY, $6.50. United Nations, 1956. Available through International Documents Service, Columbia University Press, 2960 Broadway, New York 27, N.Y.

Three additional volumes in the U.N. series on the Proceedings of the International Conference in Geneva, August 1955.

RECOMMENDED PRACTICE FOR THE DESIGN AND CONSTRUCTION OF PRESSURE-RELIEVING SYSTEMS IN REFINERIES, by the American Petroleum Institute. $1.50. Available from J. A. McNally, A.P.I., 50 W. 50th St., New York 20, N.Y.

PETROLEUM AND NATURAL GAS (a chapter from *Mineral Facts and Problems*), by R. A. Cattell et al. U.S. Bureau of Mines, Bulletin #556, 1955. Supt. of Documents, U.S. Government Printing Office, Wash., 25, D.C. 40¢.

A review of the part played by petroleum and natural gas in the United States, from its early history to present status.

Bulletins and Brochures

How processing and power piping costs can be reduced substantially—in materials, design and construction is shown in a new 12-page brochure published by The M. W. Kellogg Co., 225 Broadway, New York, N. Y. The publication details the Kellogg "general analytical method of piping flexibility analysis," which involves the development and solution of simultaneous equations for determining forces and moments in the piping system. From these forces and moments, stresses and deflections are calculated. Since the analyses are not based on approximations or "short-cut" calculations, it is possible to specify more closely to the theoretically perfect piping design, thereby avoiding excessive and costly margins of safety.

Ingersoll-Rand's new 20-page, 2-color Process Pumps bulletin fully describes their vertically split, single-stage and two-stage type process pumps, and is available on request. The bulletin carries design features of the pumps, dimension tables, cross sectional and installation views, plus a 2-page chart showing the extensive interchangeability of parts through the entire line of pumps.

The units are built in accordance with latest API specifications. The range of coverage is from 1 to 8 inches including capacities to 3200 gpm, heads to 925 feet, at temperatures to 800° F. For copies of the bulletin, contact your nearest I-R branch office, or write to Ingersoll-Rand Co., 11 Broadway, N.Y. 4.

PIPELINES TO THE FUTURE: a brochure by the Monsanto Chemical Co., 445 Park Ave., New York 22, N.Y. Describes technical and market considerations involved in the use of plastic pipe.

BULLETIN 7040, Minneapolis-Honeywell Regulator Co., Indus'l Div'n, Wayne and Windrim Aves., Phila. 44, Pa. Describes new Honeywell small-case Indicating Pressure Controller, available in ranges from 0-50 to 0-200 psi, with on-off or 10% Throttlor control.

THE TEXAS STORY, by Melvin Fenichell. Reprinted from *Barron's* national and financial weekly, Dec. 26, 1955. History of The Texas Co. from Spindletop to Williston, prepared by Harris, Upham & Co.'s geologist. Available from Broderick & Coleman, 52 Broadway, New York 4, N.Y.

Reports and Surveys

SUMMARY OF SECONDARY RECOVERY OPERATIONS IN OHIO TO 1955, by Jack Cashell, chairman, and members of the Ohio Secondary Recovery Committee. 9 pp., 3 illus., 1 table.

WATER-FLOOD OPERATORS IN ILLINOIS OIL POOLS DURING 1954, by Paul A. Witherspoon and Edwin G. Jackson, of the Illinois Geological Survey, and members of the Illinois Secondary Recovery and Pressure Maintenance Study Committee. 63 pp.; 20 illus., 3 tables. Both reports published by the Interstate Oil Compact Commission, P.O. Box 3127, Oklahoma City 5, Okla., 1956.

The report by Mr. Cashell's committee reviews secondary recovery operations in Ohio, including a history of the air and gas repressuring and water-flooding. Nineteen projects are included in the table of operations in this state.

The report on water-flood operations in Illinois oil pools reveals that during 1954 waterflooding produced approximately 18 million barrels of oil in Illinois. There were 232 waterfloods reported in operation, and these projects recovered 15,985,000 barrels of oil. An additional 2,129,000 barrels were estimated to have been produced by "dump" flooding. At the end of 1954, the cumulative water-flood recovery was 73,800,000 barrels. The history of the Lake Centralia-Salem field, the formation of the Salem unit, and the initial water-flood operations in this unit are summarized by Richard W. Love. Water-flood operations in the old oil fields of eastern Illinois are reviewed by L. C. Powell.

THE VALUE LINE INVESTMENT SURVEY, pub. weekly by Arnold Bernhard & Co., Inc., investment advisors, 5 E. 44th St., N.Y. 17, N.Y.

The most critical problem confronting the oil industry at present is how to manage imports of foreign-produced crude oil, according to a recent issue of the *Survey*. With imports capturing a larger and larger share of the petroleum market, even under current boom conditions, the clamor of domestic oil producers for governmental action to limit oil imports has continued, notes the report.

At the present time, voluntary controls under Federal prodding appear in the process of being imposed. Direct federal government restriction of imports is a threat if the voluntary limitations do not prove satisfactory.

Hence, the Value Line survey points out, imports are likely to be restricted one way or another. This will tend to ease domestic pro-rationing restrictions next year and will tend to slow up the earnings gains of the oil companies which import heavily from the Middle East. The survey concludes that the best opportunities for investors may be found among the relatively underpriced domestic and Canadian companies rather than among shares of companies that have become overpriced.

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Marine Field Faces Vast Expansion

(*Continued from page 63*)

By drilling more and more wells in each succeeding year, the United States has been able to keep its reserves ahead of withdrawals for current use. Of recent years, however, more and more of these additions have come from step-outs and the extension of existing fields. The multi-million-barrel field has become a rarity and the majority of discoveries are well below the million-barrel rating. There is no certainty, of course, that fields rivalling those that made history in the twenties and thirties may not still be found in the continental area of the United States, but the downward trend in relation to total drillings is obvious from the yearly statistics.

Demand for petroleum products in the United States continues to increase at a rate higher than the growth of reserves and already requires a substantial quantity of imports to supplement domestic production. Economists who endeavor to trace the probable course of future requirements estimate that by 1965 the country will need imports of around three million barrels daily, counting on a continuation of the current rate of additions from domestic output. A commission which made a study of energy resources a few years ago estimated that by 1975 the country would be importing something like twelve million barrels daily. If large additions to domestic supplies can be obtained from offshore areas, it will lessen dependence upon imports.

Estimates of potential recovery from offshore areas in the Gulf remain very largely in the field of conjecture. Men who have been closely associated with past progress in this area venture opinions that recoveries will run to impressive figures in the billions, while the more optomistic assert that its ultimate production may equal the entire past output from the land portion of the nation.

While the intensive drive in marine exploration will be centered in the Gulf of Mexico for the immediate future, oil interests in other parts of the world are exhibiting keen interest in undersea possibilities. One of the areas in which exploration is active is in the Persian Gulf. Shell has been conducting surveys of an extensive area off the shores of Qatar, while D'Arcy Exploration Co. in association with Compagnie Francais des Petroles, is conducting similar work off the Trucial Coast and within the past few weeks Kuwait has announced its intention of testing the waters bordering that sheikdom. On the opposite side of the world, Shell is seeking an offshore extension of its Borneo field while similar projects are under consideration in several other countries.

Record U. S. Oil Investment

The U. S. petroleum industry spent a record $4 billion in 1955 to achieve a 6.2 percent increase in domestic oil producing capacity, according to W. M. Vaughey, Jackson, Miss., retiring president of the 12,000-member Independent Petroleum Association of America. He said that "confidence for 1956 and the years ahead" was encouraged in the past year by (1) Outstanding performance by the oil industry in keeping the nation supplied with petroleum and its products, and (2) significant progress by the federal government toward a sound and more consistent policy as to oil and gas.

Mr. Vaughey released a preliminary statistical summary of the industry's 1955 accomplishments, showing that domestic oil and gas producers drilled approximately 57,000 wells during the year—an increase of 5.7 percent over the record set in 1954.

Erratum

In our January issue, it was stated that A/S Norske Esso, an affiliate of Standard Oil Co. (N.J.) has announced tentative plans for a 30,000 refinery in Finland. That information was not correct. The company does not have any such plans.

Richard M. Mills

RICHARD M. MILLS, former president of Mills Gas and Appliance Co., Inc. of Louisville, Ga., has been elected vice president and general manager of General Gas Corporation's eastern division headquartered in Macon, Ga. L. Hughes Browning, former vice president and general manager of Radiant Gas Service, Inc., was named manager of operations for the firm's eastern division. Martin F. Dryden, Jr. was elected vice president and general manager of General Gas' western division headquartered in Baton Rouge and Joseph Aron was appointed purchasing agent for the western division.

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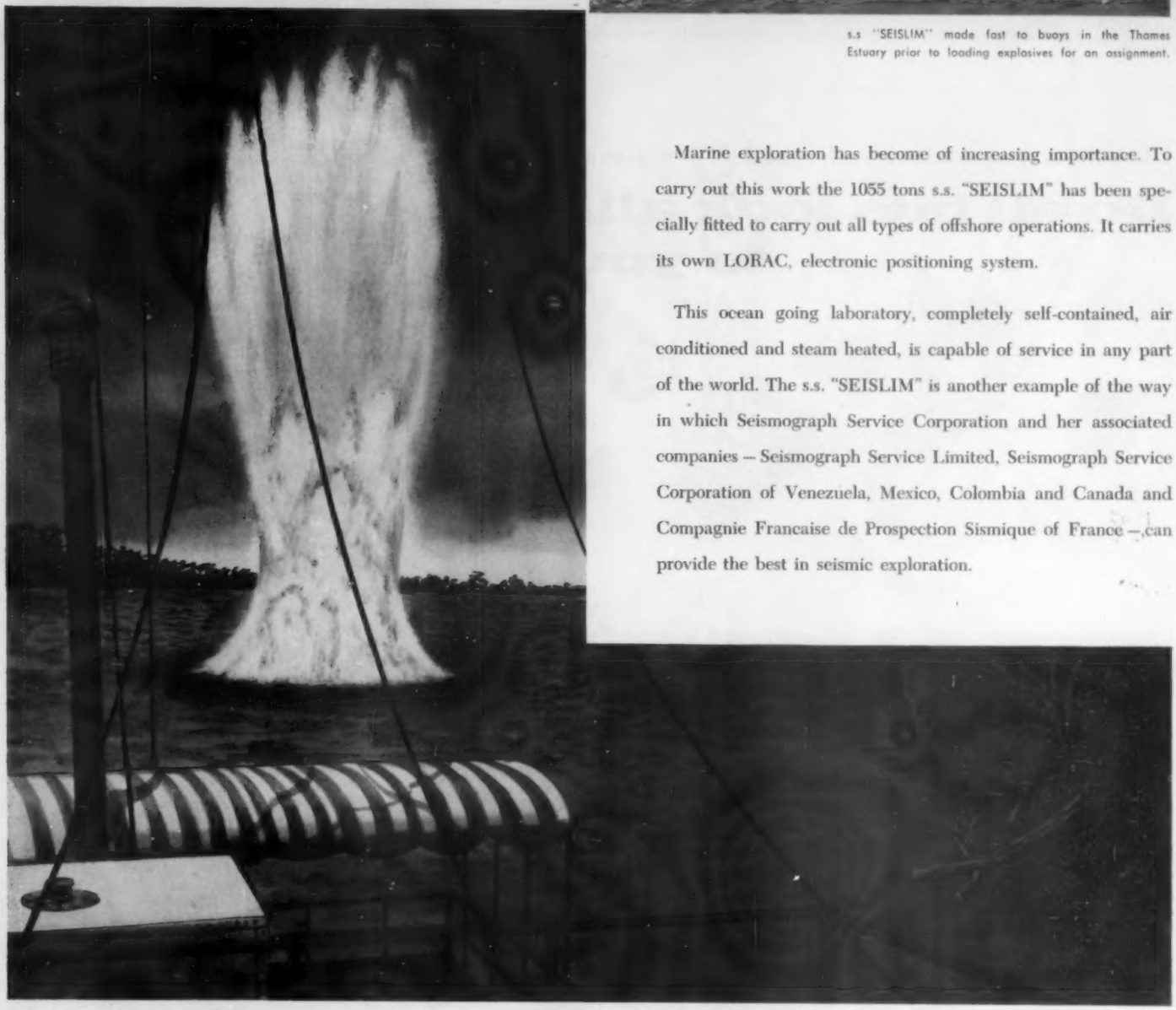

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Russell L. Forsythe

Charles R. Miller

Schlumberger Promotions

Russell L. Forsythe and Charles R. Miller have been promoted by Schlumberger Well Surveying Corp. Mr. Forsythe has been promoted to assistant manager of the Pacific Coast area with headquarters in Los Angeles and Mr. Miller has been promoted to manager of the Kansas division replacing Mr. Forsythe.

Dravo Corp., Pittsburgh, has completed construction of this new "floating" river dock on the Ohio River, just below Louisville, Ky., for Triangle Refineries, Inc., Houston, Texas. The barge is fastened to the cells by a guide arrangement and floats up and down as the river level fluctuates. The steel walkway connects the docks to the shore and supports pipe lines.

J. Prince Warner

J. PRINCE WARNER has been named general manager of manufacturing by Esso Standard Oil Co. He succeeds Harold G. Mangelsdorf who became a member of the company's executive committee.

Meyer Retires as Foote Chairman

H. C. Meyer, chairman of the board of Foote Mineral Co., Philadelphia, announced his retirement both as chairman and board member on December 31, after 50 years of service to the company. Mr. Meyer is today one of the country's leading authorities on commercial mineral deposits.

J. H. Castel

Paul Charrin

Contributes Safety Patent

Paul Charrin, president of Perforating Guns Atlas Corp., Houston, has announced that all companies now or hereafter licensed to operate under the Jet Process in the perforating of oil and gas wells will be granted a royalty-free license to the PGAC safety patent (No. 2,703,053) designed to prevent premature detonation.

"The conventional blasting cap used in jet perforating guns has always been a source of danger to life, wells and other property," Mr. Charrin said. "This is because it requires only about 1/10 of a watt of electrical energy to detonate the cap and thereby accidentally fire the whole gun.

"This inherent weakness of the conventional blasting cap," Mr. Charrin continued, "was determined years ago by PGAC engineers when they discovered that such infinitely small amounts of electrical energy could be picked up by the firing circuit from stray currents or from discharges of static electricity around or within the well."

PGAC engineers under the direction of J. H. Castel, executive vice president, devised a blasting cap assembly, combining a high-resistance element and a fuse in the circuit. The cap cannot be detonated until after its fuse is burned away by a relatively high current which must be introduced by the simultaneous closing of two electrical circuits which, in turn, can be accomplished only by two hands simultaneously and intentionally operating two separate switches on the control panel. The new blasting cap assembly and its unique firing circuit are protected by U. S. Patent No. 2,703,053.

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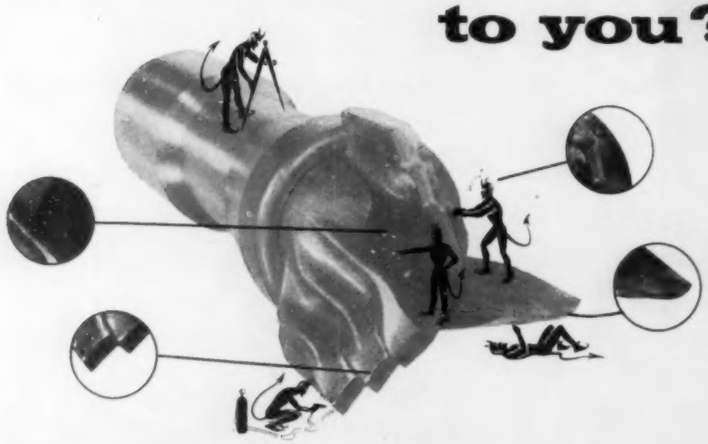

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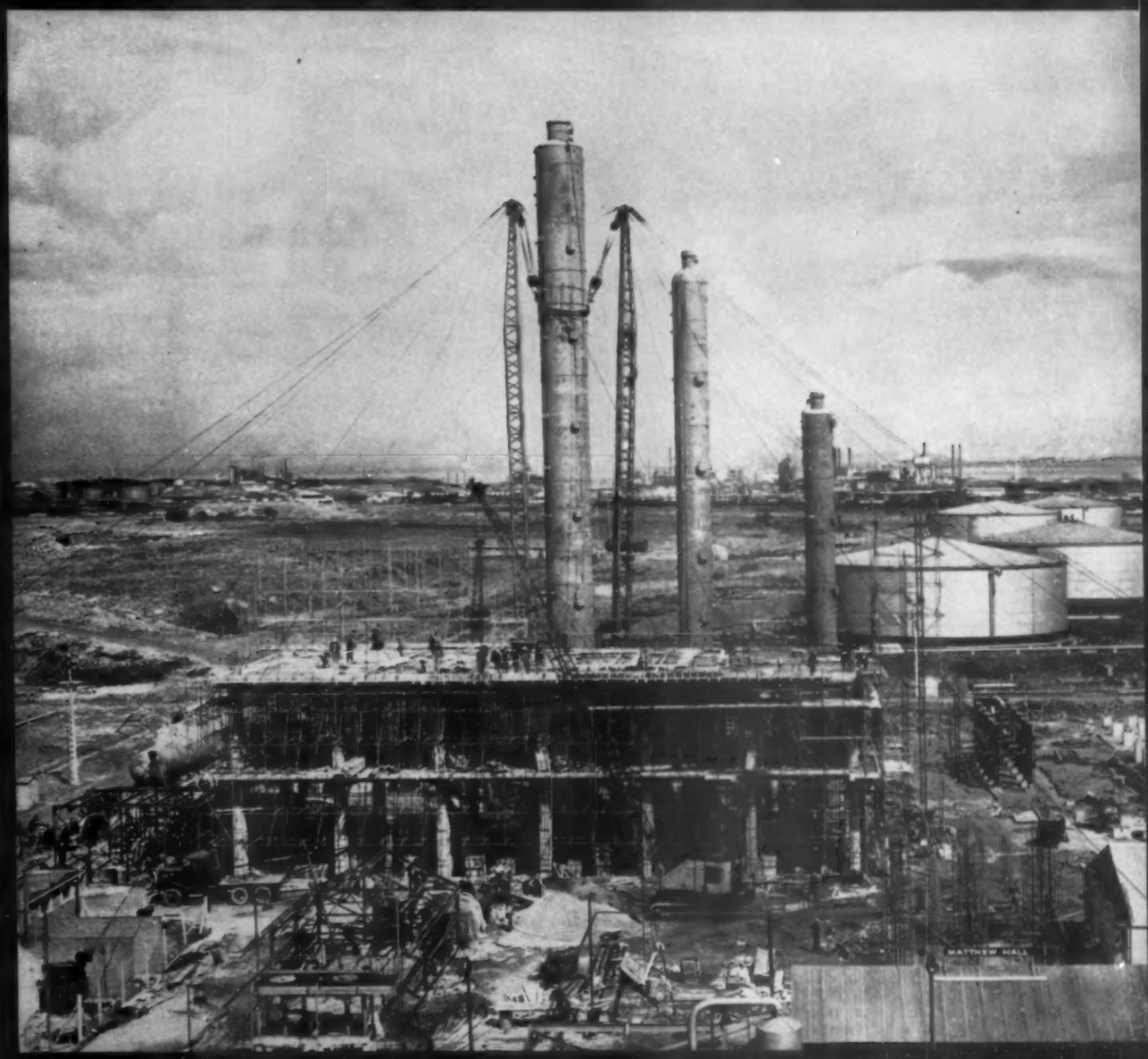

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Dresser Earnings Rise

Sales and earnings of Dresser Industries reached an all-time high in 1955 according to the company's annual report. Net earnings were $10,365,542 on sales of $164.7 million compared with a net of $9,660,031 on sales of $157 million the previous year. The 1954 earnings included a non-recurring profit of $611,000. Earnings per share were $5.15 in 1955 compared with $5.05. Dresser's preferred stock was retired in 1955 by purchase and conversion.

U. P. Buys Gas Turbines

The Union Pacific Railroad has ordered fifteen 8,500 hp gas turbine-electric locomotives from the General Electric Co. and expects to buy 30 more at a total cost of $38 million. Currently Union Pacific has a fleet of 25 G. E. gas turbine-electric locomotives in service of 4,500 hp. The new locomotives will burn Bunker C fuel.

Infilco Company In Australia

Infilco Inc. has begun an Australian subsidiary with offices in Sydney. This is Infilco's third foreign subsidiary. The other two are located in Mexico and Canada and a fourth will be in Japan.

Schlumberger Purchases Johnston Testers

Schlumberger Well Surveying Corp. has purchased outright the entire assets of Johnston Tester, Inc. Sale price to Johnston Testers' stockholders was $8,100,000, or $13.50 per share. No organization changes are planned for the newly acquired company. It will be operated under the same name, Johnston Testers, Inc., as a wholly-owned subsidiary of Schlumberger. M. D. Johnston, the founder of Johnston Testers, will remain its president.

R. S. McLaughlin

R. S. McLAUGHLIN has been appointed export manager of Tide Water Associated Oil Co. He will assume overall direction of Tide Water's product sales abroad, with headquarters in New York City.

West Coast Gas Line Progresses

Of major interest in the lower mainland of British Columbia this spring have been the financing plans of Westcoast Transmission Company Ltd. which has already started work on a natural gas pipe line from the Peace River region to the B.C. coast.

These plans were revealed when the corporation filed with the U. S. Securities and Exchange Commission, a registration statement covering 32-year subordinate debentures to the value of $20,500,000 in U.S. funds, plus 615,000 shares of capital stock. Underwriting the offering is a group of investment firms headed by Eastman Dillon Co.

Pacific Northwest Pipeline Corp., the U.S. firm which will take Peace River gas from Westcoast lines at the B.C.-U.S. border at Sumas, Washington, laid 183 miles of pipe during December on its line from the San Juan field of New Mexico to the international boundary. Pacific Northwest will sell the U.S. gas to B.C. Electric Company at Huntington until the Canadian line is built down from the Peace River. First natural gas from the U.S. lines is expected to reach Vancouver this summer.

British Columbia's first pipe line, the Trans-Mountain Oil Pipe Line from Edmonton to Vancouver, is now carrying an average of 110,000 barrels daily, distributed almost equally between refineries in B.C. and Washington. C. D. Bailey, Trans Mountain's chief engineer recently announced construction of an $800,000 pumping station at Laurel, Washington to serve General-Petroleum at Ferndale and the Shell refinery at Anacortes.

The new station is being built to ensure that the Washington spur line, which is 20-inch with 16-inch laterals to the refineries, would pump full main line deliveries when required from the main Trans Mountain 24-inch line from Edmonton. This new construction, which means an expenditure of $500,000 in Washington state with Trans Mountain spending $100,000 a year in wages and supplies, has started talk of another pipe line from the prairie fields to the Pacific Coast.

Such talk was started when Trans Mountain shipped its first load of Alberta crude to California. Pipe Line officials, however, said at the time it was a single shipment and could not be taken to mean a continuing movement.

First pipe from the United Kingdom arrived in Vancouver Feb. 13 for the Westcoast line when a shipment of 30-inch pipe was unloaded from the freighter Germa which sailed from Middlesborough, England in January.

Renewed interest in the petroleum possibilities of British Columbia has been sparked recently by reports which predict discovery of commercial oil wells in the northern section of the province. Richfield Oil Corp. of California is drilling 61 miles north of Fort St. John and 12 miles west of successful gas completion in the Nig Creek aren.

What can *HARBORMASTER OUTBOARD PROPULSION* do for you?

Harbormasters are complete marine power and steering units . . . *in one package . . . easily installed for immediate use* . . . combining outboard maneuverability with heavy-duty performance. Shown here are just some of the uses where their great maneuverability and heavy-duty performance are paying off.

If you need easily installed power, better steering control, safety in shallow water, easier maintenance, more efficient performance, simpler hull design, more cargo space, bigger payloads, or simplified crew operation . . . you should investigate the benefits of Harbormaster Outboard Propulsion and Steering.

In the new Harbormaster Catalog you'll find detailed information and also many interesting Harbormaster installation photos. Send for your copy today.

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For Coupling Bracing Tubes to Strengthen Scaffold.

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For Securing Two Tubes Firmly Together, End to End.

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For fixing Putlogs or Transoms to Horizontal Tubes.

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For Coupling Upright Tubes to Horizontal Tubes.

SOLID STEEL DROP-FORGED SCAFFOLDING FITTINGS
MANUFACTURED TO B.S.S. 1139-1951
SPECIFIED BY LEADING ENGINEERS AND CONTRACTORS

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LONDON OFFICE: 6, LYGON PLACE, LONDON S. W. 1
TELEPHONE: SLOANE 7291-3 **TELEGRAMS:** DUBELGRIP, SOWEST, LONDON

PGAC executives and key management men at the company's annual management conference at Houston; shown here are a group from the southwest area: Seated, left to right, J. H. Castel, executive vice president; Ralph Davis, shop superintendent; George Decker, south Texas district manager; W. L. Young, sales manager; Al Kangers, Kansas district manager. Standing, left to right: Ruch George, north Texas district manager; J. H. Russell, manager of operations; Harry Hacke, superintendent of operations; Jack Howse, Oklahoma district manager; Paul Charrin, president; Jack Henley, west Texas district manager; Floyd Taylor, south Louisiana district manager; C. C. Hinson, assistant to the president; Sarge Haynie, Ark.-La.-Tex. district manager.

P.G.A.C. Annual Management Conference

Top executives of Perforating Guns Atlas Corp. recently met at Houston with the company's key management men from the general and branch offices for their annual management conference. Operations during 1955 were analyzed and plans completed for again expanding the company's logging, perforating and other services in 1956.

Paul Charrin, president, revealed that PGAC's record-breaking business during 1955 had already resulted in capacity operations at the company's new 10-acre Houston main plant, opened only last April.

Mr. Charrin explained that it had been found necessary to continue many operations in the old plant until additional buildings planned for the new site could be erected and equipped. "Our six new branches put in operation in this country and abroad during 1955," he said, "now make additional main plant facilities an urgent part of our 1956 planning."

J. H. Castel, executive vice president of PGAC, reviewed the firm's recent research activities which have developed new commercial logging and perforating techniques.

H. A. W. Kidd

H. A. W. KIDD has been named assistant to the manager of Magnolia Petroleum Company's natural gas department. He has been assistant to the director of Socony Mobil laboratories with headquarters in New York for the past three years. Before that time he spent nine years at Magnolia' field research laboratories in Dallas.

Complete Platformer

Anderson-Prichard Oil Corp. has completed a 4,000 barrel Platformer at its Arkansas City, Kan. refinery. Universal Oil Products Co. designed, engineered and licensed the unit. Provision for future operation as a Rexformer was included in the design.

Dowell's remote controlled Allison pumper. The engine is located in the hooded compartment behind the truck cab. The small radiator above the pump is for cooling and the oil in the torque convertor which is used to transmit power from the engine to the pump.

Remote Controlled Pumper

A new high-pressure pumping unit for acidizing and fracturing service has been developed by Dowell Inc. The unit incorporates a 12-cylinder Allison aircraft engine which developes 1,100 hp at 2,600 rpm. It will operate continuously at 600 hydraulic horsepower.

A unique system of controlling the engine and pump from an instrument panel 125 feet from the truck is used for the first time on well treating equipment, according to Dowell engineers. This feature permits the service engineer or equipment operator to perform all necessary operating functions of the engine and pump. Instruments provide information at all times on all operating conditions. Automatic safety features will cause the pump or engine to stop should pump pressure go too high. A CO_2 fire control system can be operated from the remote control panel. The engine is completely hooded for this purpose and to protect the engine against the danger of splashing oil.

Pressures as high as 10,000 psi and injection rates up to 20 barrels per minute can be handled by the new pumper. Weight is greatly reduced by the inclusion of more than 1,000 pounds of magnesium in the gear housing and base of the triplex pump.

Koenig ALL-STEEL CABS for JEEPS

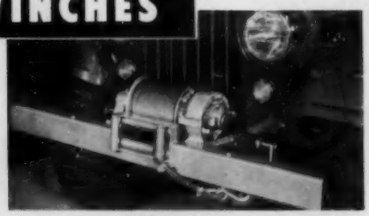
FULL AND HALF CABS

KOENIG ALL-STEEL CABS HAVE THESE SUPERIOR FEATURES:

- Protection—Complete protection in all kinds of weather . . . valuable cargo protected by locks.
- Safety—All-steel, welded construction. No rivets . . . safety glass throughout.
- Comfort—Full panel-board head lining and masonite door lining . . . no vibration.
- Convenience—Roll-down windows, full opening.

KING WINCHES

King Winch on R-140 and R-160 International



P.T.O.-driven King Winch on Willys Jeep *

KING WINCHES FOR KING-SIZE PULLING JOBS

For all Willys Jeeps, trucks and 4 x 4 station wagons . . . also for Ford, Chevrolet, International and Dodge trucks.

King Winches keep you moving through the most difficult terrain . . . you get action where there's no traction with dependable pulling power. King power winches have pulling capacities of 8,000 to 19,000 lbs.

*POWER-TAKE-OFF-DRIVEN KING WINCH MODELS 130J and 131J for CJ-3B and older-model Jeeps, can be transferred to CJ-5 and CJ-6 Jeeps—NOTHING EXTRA NEEDED.

Koenig Jeep cabs and King Winches for Willys vehicles are available through Willys Motors, Inc., and Willys-Overland Export Corp. distributors or dealers. Write for free descriptive literature.

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Forms Engineering Firm

Williams Brothers Corp., has been formed as a subsidiary of Williams Brothers, Tulsa pipe line construction firm. The new company will handle engineering work of the various Williams' enterprises in all parts of the world.

John H. Williams is president of the firm. C. M. Collins is executive vice president; Vincent E. Butler, vice president; and Wilson N. Gilliat, chief engineer.

Macobar Appointment

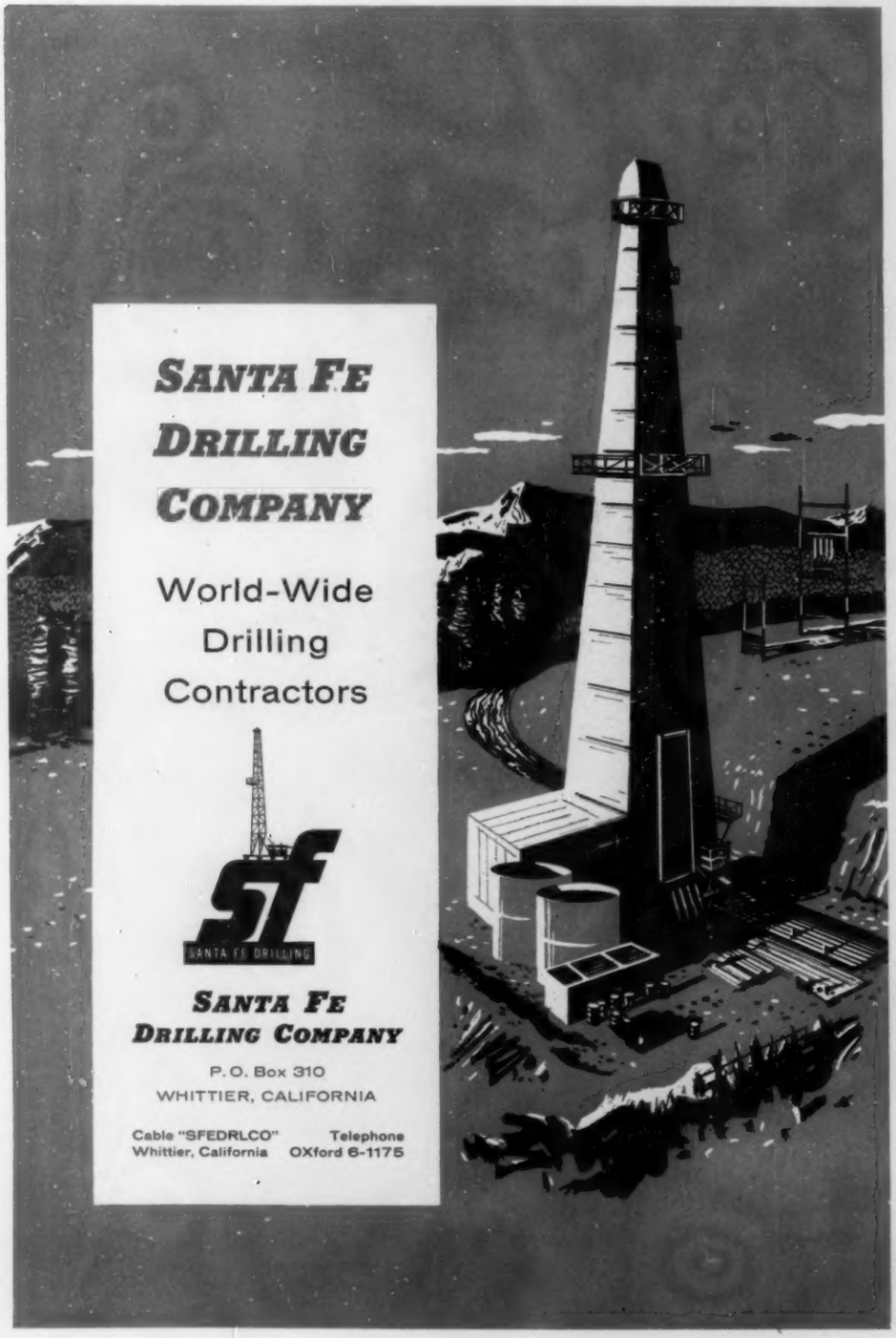
David G. Willis has been appointed publications and publicity assistant of Magnet Cove Barium Corp. He will assist in the editing of the company's internal publication, and the preparation of its publicity material.

Socal's Facilities Increased

Standard Oil Company of California has announced that Standard Oil Company of Texas, a subsidiary, will expand its refinery facilities at El Paso by more than two-thirds, to increase the output to 61,000 b/d of petroleum products from the present 36,000 b/d. Pasotex Pipe Line Company, another subsidiary, will further increase the capacity of the crude oil pipe line running from Wink to El Paso by 45%.

Charles Willis Hughes

Charles Willis Hughes, 64, prominent Louisiana oilman and manager of the production division of Arkansas Fuel Oil Corp., suffered a fatal heart attack at his home in Shreveport December 8.



Harrison B. Haney

HARRISON B. HANEY, vice president of Tide Water Associated Oil Co. has been appointed manager of transportation of the company. In this post, a new one, Mr. Haney is responsible for planning and coordination of all company transportation activities, including marine and pipe line operations.

Bowes Joins Panther

Vincent E. Bowes, former manager of the petroleum service division of Oakite Products, Inc., has joined the staff of Panther Chemical Co. as assistant to the general manager. He will head the system of petroleum refinery servicing. Plans now under way are creating a nationwide staff of technical service representatives for Panther, trained as trouble shooters for the petroleum industry's cleaning and production problems.

G.S.I. Vice President

C. M. Moore, Jr. formerly in charge of Geophysical Service, Inc., Canadian operations, has been elected vice president. He will maintain offices in Dallas, and will direct GSI's petroleum exploration activities in the Eastern Hemisphere. As a result of Mr. Moore's appointment, expanded duties were announced for vice president R. C. Dunlap, Jr. In addition to his present duties as director of U.S. operations, he will assume responsibility for Canadian operations.

R. G. Chadderdon

Appoints Export Representative

R. G. Chadderdon has been appointed export representative of Houston Oil Field Material Company, Inc., of Houston. His offices will be at 509 Madison Ave., N.Y. He has been with HOMCO for the past nine years. He plans to visit foreign fields, periodically, to aid in fishing or cutting, directional drilling or oil well surveying problems.

WESTCOAST TRANSMISSION COMPANY LIMITED
IMPERIAL OIL LIMITED
TRANS MOUNTAIN OIL PIPE LINE COMPANY
GENERAL PETROLEUM CORPORATION
SHELL OIL COMPANY
UNION OIL COMPANY OF CALIFORNIA
INTERPROVINCIAL PIPE LINE COMPANY
TRANS CANADA PIPE LINES LIMITED
MONTANA DAKOTA UTILITIES COMPANY
HANNA NICKEL SMELTING CO.
U. S. ATOMIC ENERGY COMMISSION
HERCULES POWDER COMPANY
PACIFIC GAS AND ELECTRIC COMPANY
CONTINENTAL CAN COMPANY, INC.
TODD MACHINERY AND CHEMICAL CORPORATION
HERCULES POWDER COMPANY
ALLIED CHEMICAL & DYE CORPORATION GENERAL CHEMICAL DIVISION
SALT LAKE REFINING COMPANY
FOOD MACHINERY AND CHEMICAL CORPORATION
SHELL CHEMICAL CORPORATION
PACIFIC GAS AND ELECTRIC COMPANY
THE DOW CHEMICAL COMPANY
UTAH POWER & LIGHT COMPANY
UNION OIL COMPANY OF CALIFORNIA
STANDARD OIL COMPANY OF CALIFORNIA
SIDE WATER ASSOCIATED OIL COMPANY
NORRIS THERMADOR CORPORATION
OWENS-CORNING FIBERGLAS CORPORATION
SOUTHERN CALIFORNIA EDISON COMPANY
WESTERN ELECTROCHEMICAL COMPANY
PACIFIC GAS AND ELECTRIC COMPANY
CONTINENTAL CAN COMPANY, INC.
UNION OIL COMPANY OF CALIFORNIA
GENERAL PETROLEUM CORPORATION
RIVERSIDE CEMENT COMPANY
STANDARD OIL COMPANY OF CALIFORNIA
PACIFIC GAS AND ELECTRIC COMPANY
SOUTHERN CALIFORNIA EDISON COMPANY
LEVER BROTHERS COMPANY
THE DOW CHEMICAL COMPANY
SALT RIVER POWER DISTRICT
IMPERIAL OIL LIMITED
DOW CHEMICAL OF CANADA LIMITED
SOCONY MOBIL OIL COMPANY, INC.
TENNESSEE GAS TRANSMISSION COMPANY
LEVER BROTHERS COMPANY
THE CALIFORNIA OIL COMPANY
SOCONY MOBIL OIL COMPANY, INC.
STANDARD OIL COMPANY
LEVER BROTHERS COMPANY
(Nuclear Power Plant)
TENNESSEE GAS TRANSMISSION COMPANY
SHELL OIL COMPANY
FOOD MACHINERY AND CHEMICAL CORPORATION
FOOD MACHINERY AND CHEMICAL CORPORATION
SOCONY MOBIL OIL COMPANY, INC.
CONTINENTAL OIL COMPANY
TEXAS-ILLINOIS NATURAL GAS PIPELINE COMPANY
STANDARD OIL COMPANY OF TEXAS
PETROTEX CHEMICAL CORPORATION
MAGNOLIA PETROLEUM COMPANY
CONTINENTAL CAN COMPANY, INC.
GULF OIL CORPORATION
TENNESSEE GAS TRANSMISSION COMPANY
INTERNATIONAL BOUNDARY AND WATER COMMISSION
FLORIDA POWER & LIGHT COMPANY
CIA. PETROLERA SHELL DE CUBA, S. A.

BECHTEL

Among Major Projects...

In industry's service Bechtel jobsites cover the map from British Columbia to Cuba. Other projects are located in Hawaii, South America, England, Italy, the Middle East, Korea and the Philippine Islands.

Engineering and construction experience accumulated in many parts of the world enables Bechtel to move into any area—foreign or domestic—and complete assignments with speed and economy. "Ahead of schedule, under budget" is an objective consistently met in practice.

MAP LEGEND

- Oil Refinery
- Steam Power Plant
- Hydro-Electric Power Plant
- Chemical Plant
- Pipe Line
- Manufacturing Plant
- Atomic Energy Facility
- Smelter
- Compressor Station
- Dam
- Electrical Distribution

BUILDERS FOR INDUSTRY

BECHTEL CORPORATION • *Los Angeles* **SAN FRANCISCO** *New York*

CANADIAN BECHTEL LIMITED • *Toronto*

Charles W. Springer

Springer Heads Graver Research

Charles W. Springer, vice president of Graver Tank & Mfg. Co., Inc., has been appointed to the new position of director of research and development. He has for some years headed Graver's eastern sales. Before joining Graver, Mr. Springer was with the Draper Mfg. Co., where, in 1939, he headed the development of its then new closure division. In 1941, he was transferred to Washington, D. C., to work with the Ordnance Department, the Chemical Warfare Service and the Navy in handling development work on critical problems.

New Badger Vice President & Chairman

A. J. Broggini has been elected executive vice president and chairman of the executive committee of The Badger Manuf. Co. Before joining the Badger Manuf. Co. in 1952, Mr. Broggini was with the former E. B. Badger & Sons, Co., which he joined in 1937 and served in various engineering, sales and executive capacities.

Arch W. Baucum

ARCH W. BAUCUM, formerly assistant to the president, has been appointed general manager of foreign operations for The Texas Co. in the western hemisphere and west Africa. He assumed the new duties on January 1. Mr. Baucum joined Texaco in 1934. He was named assistant division production engineer at Houston in 1942 and became division engineer at Tulsa two years later. In 1944 he was named assistant division manager at Houston and in 1948 became assistant manager of the producing department.

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—for information on oil . . . underground for facts on mining . . . or into the backwoods for notes on lumbering. Not when we, at Imperial Bank of Canada, have a highly-skilled staff who specialize in the gathering of information on all phases of industry. For example, Mr. A. S. de Rosenroll, our resident specialist to the oil industry at Calgary, Alberta, can provide you with a wealth of up-to-date facts and figures, should you need them So, see your local Branch Manager of Imperial, if at any time you have a problem concerning finance and industry. Imperial Bank has branches coast to coast, serving business, industry and the people of Canada.

IMPERIAL
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IMPERIAL BANK OF CANADA

Permanent Magnetic Clutch

A new type permanent magnetic clutch will soon make its appearance on the American market through Locke Machine Co. Developed in Germany, this clutch requires no electric current for its operation except for an impulse for engaging or disengaging. Lack of a continuous electric current supply has proven of great interest to manufacturers of battery operated devices. This clutch will be available in the fractional horsepower range and it ir intended they be made for longer applications also

New Ignition Unit

A new ignition system for heavy-duty high compression gas engines used in the petroleum, aluminum production and power plant fields has been brought out by the Scintilla division of Bendix Aviation Corp.

The matched system cobines a new type Bendix LC magneto with the company's Hi-V transformer coil. This combination, according to George E. Steiner, divisional general manager, was engineered to meet the exacting requirements of large stationary industrial engines of 6 to 16 cylinders ranging from 1,000 to more than 4,000 horsepower.

New Refining Unit

A new 22,000 b/d refining unit for improving the quality of heating oil and other distillate fuels will be built at the Paulsboro, N. J., refinery of Socony Mobil Oil Company, Inc. The unit, designed by Socony Mobil, will employ catalytic hydrodesulfurization. This process reduces the sulfur content and improves the stability of heating oils, diesel fuels, and other distillates by mild treatment with hydrogen.

A construction contract has been awarded to the Foster Wheeler Corp. of New York.

Two New McCullough Branches

McCullough Tool Co. service branches have been opened at Natchez, Miss. and Liberty, Tex., raising the number of branches in the rapidly-expanding McCullough organization to more than 60. McCullough now has 21 branches operating in the major Texas oil fields and 2 in Mississippi.

Jack Reynolds will manage Natchez operations and V. M. Hocut is in charge at Liberty.

THE STEEL TUBE AGE

S & L steel casing,

9⅝-inch outside diameter,

being prepared for stringing at a location

of Imperial Oilfields Ltd., Alberta, Canada

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The largest manufacturers of steel tubes in Europe

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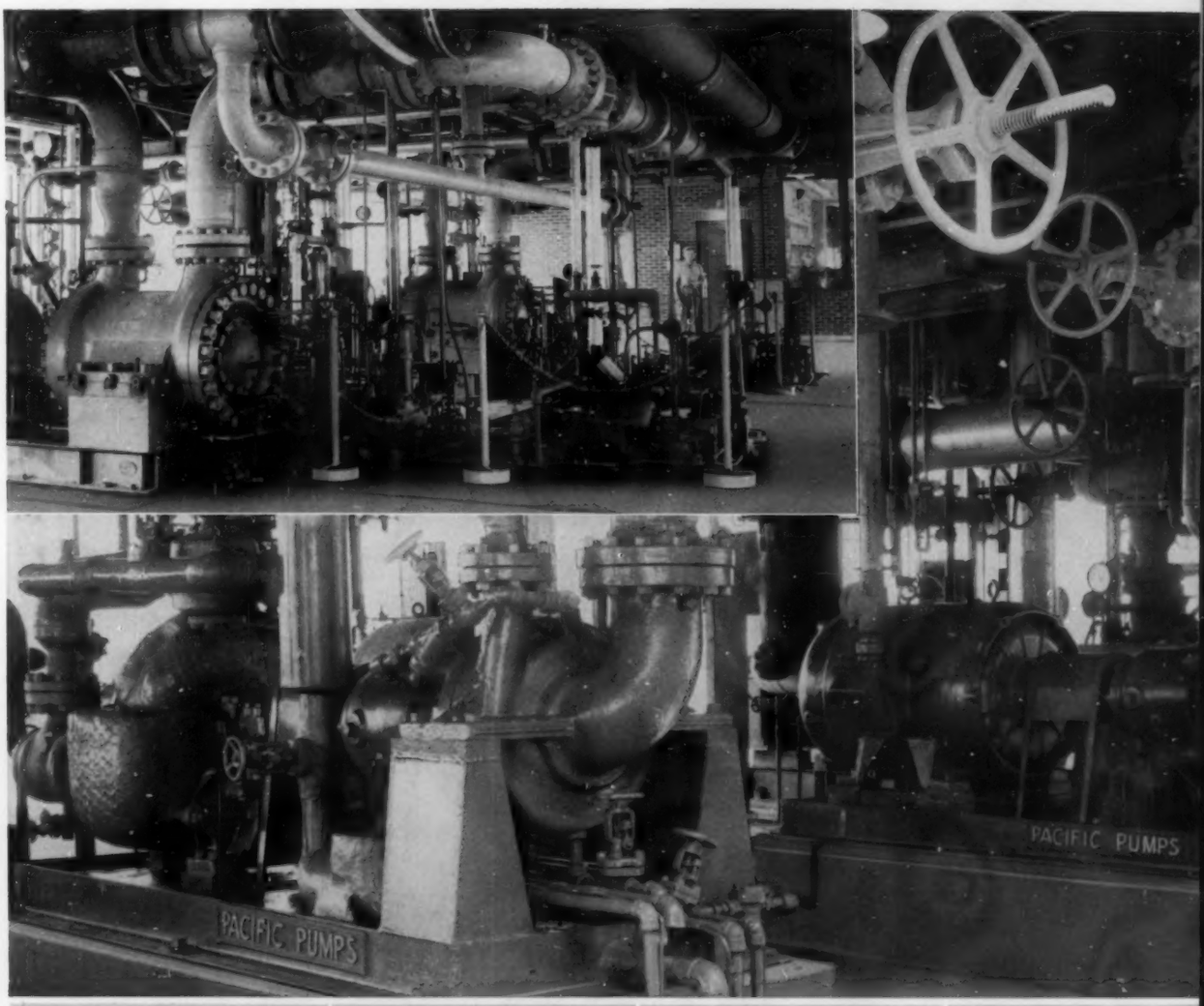

IDECO

IDECO, Dallas, Tex.—Hydrair and Power Rigs; Full-View Masts; Substructures; Single, Dual and Drive-In Rambler Rigs; Blocks, Swivels, Rotaries; Mud Pumps; Petroleum Equipment and Supplies.

Magcobar.

MAGNET COVE BARIUM CORP., Houston, Tex.—Magcobar and Magcogel drilling muds and other specialized oil well drilling fluids and chemicals.

Security

SECURITY ENGINEERING DIVISION, Dallas, Tex., Whittier, Calif. — Rock bits, reamer rock bits and hole openers; reamers, casing scrapers and Neo-Red rubber stabilizers.

CLARK

CLARK BROS. CO., Olean, New York—Gas turbines, engines, and reciprocating, centrifugal and axial flow compressors — gas, steam, electric and diesel driven.

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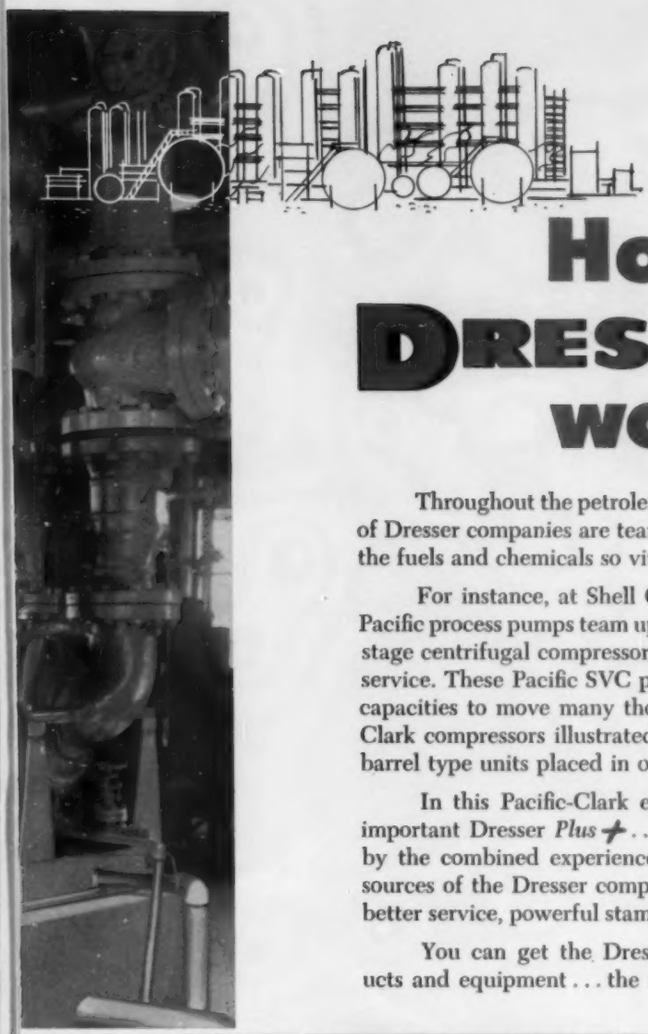
PACIFIC

the pump with the extra "oomph"

For more than thirty years, Pacific has supplied the refining, processing, and other industries with a range of pumps for every purpose. In the petroleum industry, Pacific pumps handle everything from the production of crudes to the finished, marketable product. For every industry, Pacific offers a rugged, durable pump for practically every purpose ... single-stage, multi-stage, horizontal and vertical types, with axial and radial split cases ... for all pressures and for extreme sub-zero temperatures and up to 850°F. Whatever your pumping requirements, you can rely on a Pacific pump to handle the work efficiently and economically.



How the DRESSER *plus* + works...

Throughout the petroleum and petrochemical industries, products of Dresser companies are teamed together to help produce and process the fuels and chemicals so vital to the modern world.

For instance, at Shell Oil Company's Deer Park, Texas refinery, Pacific process pumps team up with Clark heavy duty, barrel type multi-stage centrifugal compressors handling recycle hydrogen on reforming service. These Pacific SVC pumps shown in the large illustration have capacities to move many thousands of gallons of liquid per day. The Clark compressors illustrated at upper left are the first of these Clark barrel type units placed in operation.

In this Pacific-Clark equipment team the operators obtain the important Dresser *Plus* + . . . the dependability of equipment insured by the combined experience, research, engineering facilities and resources of the Dresser companies. This is realized in greater strength, better service, powerful stamina, and longer life.

You can get the Dresser *Plus* + by specifying Dresser products and equipment . . . the standard of comparison the world over.

ROOTS-CONNERSVILLE BLOWER DIVISION, Connersville, Ind.— Rotary positive blowers, gas pumps, centrifugal blowers, exhausters, and positive displacement meters.

LANE-WELLS CO., Los Angeles, Calif., Houston, Tex., Oklahoma City, Okla.—Electric and Radioactivity Well Logging, Koneshot perforating and bullet perforating, packers and bridging plugs.

DRESSER-IDECO DIVISION, Columbus, Ohio — Radio and television broadcasting towers, steel buildings, aircraft hangars, mechanical parking garages, electric power substations.

DRESSER MANUFACTURING DIVISION, Bradford, Pa. — Pipe line couplings, pipe repair sleeves and clamps, weldments, forgings, welding fittings, flanges, rings.

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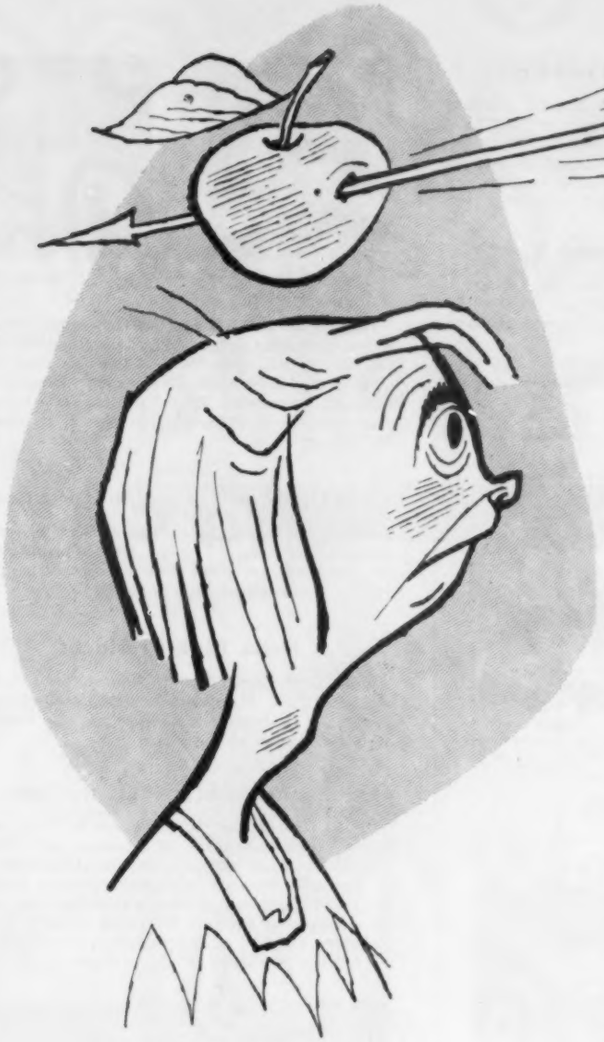

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. . . is that the results of any survey are as accurate as the technique used . . . that savings in time and man power cut survey costs and so increase the area covered . . . that on these accounts, mobile Decca Chains have proved *in the field* to be the most efficient and flexible of all electronic position fixing techniques.

Precise position fixing with low ambiguity and true repeatability over long or short periods.

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Built-in electronic referencing, eliminating "reference buoys."

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Automatic and continuous map display of track and position with the Decca "Track Plotter."

DECCA NAVIGATOR

Mobile Chains for every kind of survey

THE DECCA NAVIGATOR COMPANY LIMITED, LONDON, ENGLAND

Heads Selas Sales

Elmer B. Dunkak has been appointed to the newly created position of vice president, sales, for Selas Corp. of America, Philadelphia. Mr. Kunkak brings to Selas more than 20 years of experience in the fields of combustion and process equipment and is the originator of widely used improvements in process heating and controls. For the past 18 months he has served Selas as consultant to the president.

Clark Joins Houdry

John Robert Clark, Jr., of Bethesda, Md., has joined the sales organization of the chemicals division of Houdry Process Corp. Mr. Clark was previously with the Washington Brick Co., at Muirkirk, Md.

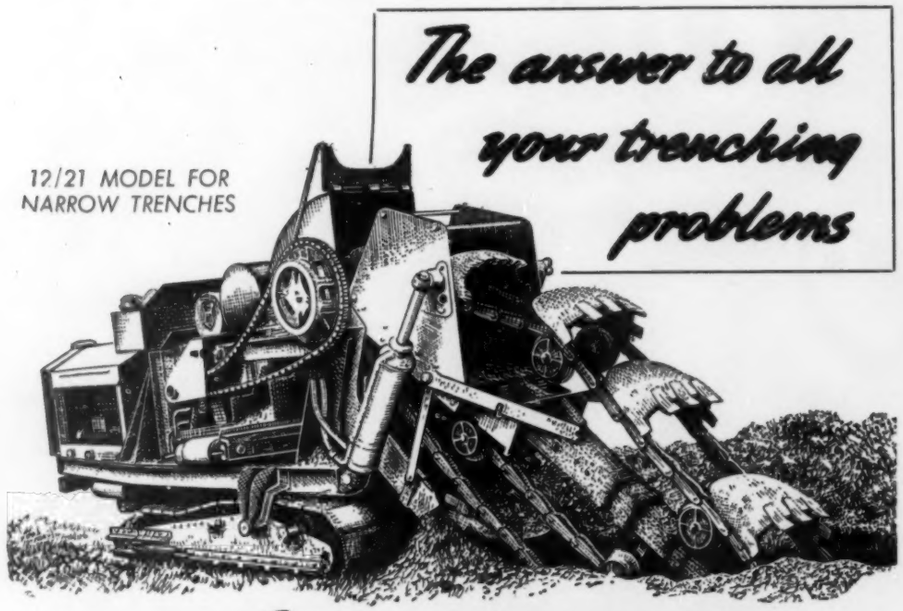
U. S. Tank Truck Fleet Up

Total capacity of the nation's general purpose tank truck fleet in petroleum service is 174,275,550 gallons, with 31,012 tank motor vehicles, according to a report adopted by the National Petroleum Council. This represents an increased capacity for general purpose equipment of 33.2% over 1952.

Sinclair 1955 Earnings Up

Consolidated net earnings of Sinclair Oil Corp. and subsidiaries for the year 1955 are expected to reach a total in excess of $80 million according to P. C. Spencer, president.

Earnings in 1955 will exceed by about $5.6 million, or 7.5%, the net earnings of $74,623,256 reported for 1954.

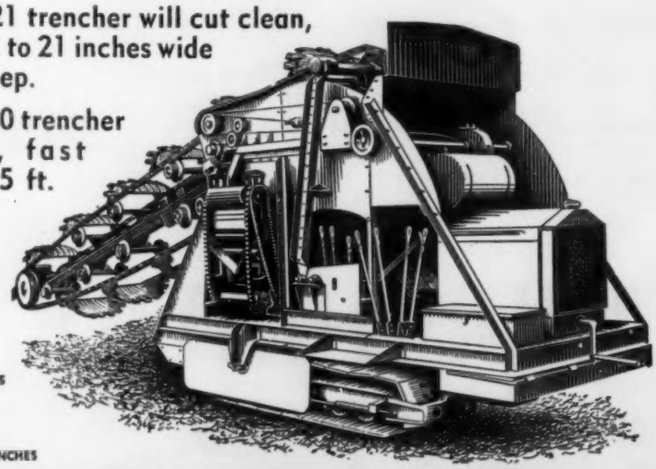


ALLEN *Super Duty* TRENCHERS

World-renowned, all-British ALLEN plant is recognised as the finest obtainable. For hard work, long life, freedom from breakdown and economical maintenance, it has no equal anywhere.

The Model 12/21 trencher will cut clean, fast trenches 13 to 21 inches wide down to 6 ft. deep.

The Model 16/60 trencher will cut clean, fast trenches up to 5 ft. wide down to 14 ft. deep.



Illustrated catalogues sent on request.

16/60 MODEL FOR WIDER TRENCHES

JOHN ALLEN & SONS (OXFORD) LTD. COWLEY OXFORD ENGLAND

Grant H. Young

R. M. Churchwell

GRANT H. YOUNG has been appointed manager of the marketing development division of The Ohio Oil Co. He will take the new position after completing the Advanced Management Program at Harvard University. R. M. Churchwell, assistant chief petroleum engineer, was named to succeed Mr. Young.

Noll Director Of Foreign Operations

Henry D. Noll has been made director of foreign operations of Houdry Process Corp. In his new post, Mr. Noll will represent both the process division and the chemicals division of Houdry.

Delta Tank President

Kenneth H. Gayle, Jr., has been elected president of Delta Tank Manufacturing Co., Inc. of Baton Rouge, La., succeeding Hal S. Phillips who has been named chairman of the board.

Joins Petrochemical Consultant

Henry Groppe has joined Joseph R. Mares as a petrochemical consultant at Houston. Mr. Groppe was most recently assistant director of development for Monsanto Chemical Company's plastics division at Texas City, Texas. His experience includes process engineering work in a Texaco refinery and a period as assistant to the manager of refining for the Arabian American Oil Co. in Saudi Arabia.

Seated left to right: Don E. Kirchner, Dave C. Washburn, Herb E. Maland, E. E. Andreason, Stewart D. Beckley. Standing: R. E. James, F. L. Crabbe, Jesse Hickman. Officers not present were Maurice F. Delano, D. T. O'Connor, N. L. Boulden.

Maland Heads New York Nomads

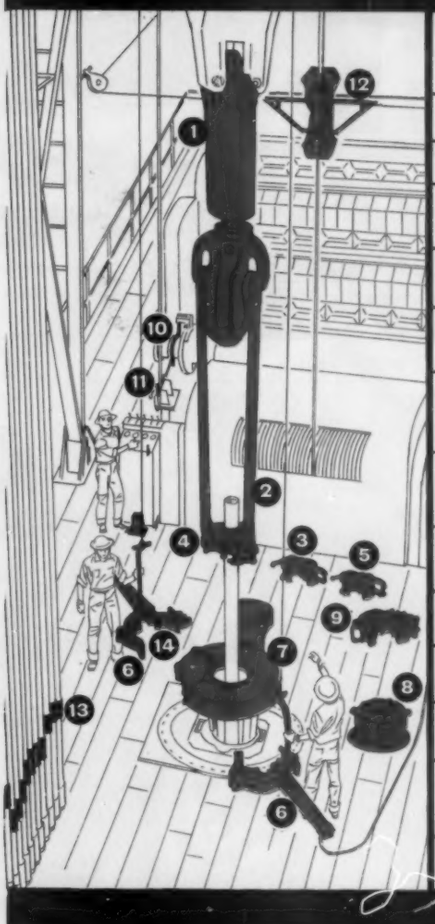
Herb E. Maland, of R. J. Eiche & Associates, will head activities of the New York Chapter of Nomads as president during 1956. Other new officers elected include Vice President Maurice F. Delano, R. S. Stokvis & Sons, Inc.; Secretary E. E. Andreason, W-K-M Manufacturing Co., Inc.; Asst. Secretary F. L. Crabbe, Black Export Co.; Treasurer Dave C. Washburn, Cameron Iron Works, Inc.; Asst. Treasurer D. T. O'Connor, D. T. O'Connor; Sergeant-at-Arms Don E. Kircher, Gardner-Denver Co.; Asst. Sgt.-at-Arms Jesse Hickman, Beckley, Haltom & Hickman; Asst. Sgt.-at-Arms R. E. James, Security Engineering Division; Regent, Stewart D. Beckley, Beckley, Haltom & Hickman; Regent N. L. Boulden, Jr., International General Electric Co., Inc.

On the World's deepest well, it's

BJ Red Iron!

Richardson and Bass Rig 25, No. 1-L LL&E, in the Lake Washington Field, Louisiana, has set a world's record for depth of hole, going more than four miles into the earth at a cost of two-million dollars. Fourteen different BJ products, ranging from tong dies to a 350-ton hook, were used on this well. Byron Jackson is proud of the part that its "Red Iron" played on this record-making well.

EQUIPMENT AND PERFORMANCE DATA



1. **BJ 4300 Super-Triplex Hook:** Supported drill string of 13,000' 4" O.D. pipe and 10,000' 2⅞" O.D. pipe (total weight 270,000 lbs.). Also handled 13,486' of 9⅝" casing (530,000 lbs.).
2. **BJ 2¼" x 132" Weldless Links:** Same performance characteristics as hook.
3. **BJ Type MGG 5" Elevator:** Used for top hole pipe handling.
4. **BJ Type MGG 4" Elevator:** Handled 13,000' of 4" O.D. pipe (5¼" tool joints) and 10,000' of 2⅞" O.D. pipe with a total weight of 270,000 lbs.
5. **BJ Type MGG 2¼" Elevator:** Handled 10,000' of 2⅜" O.D. pipe (4½" tool joints) with a total weight of 90,000 lbs.
6. **Two BJ Type B Tongs:** Handled make-up and break-out on pipe and casing from 2⅜" to 13⅜" O.D. (includes more than 150 round trips).
7. **BJ Type B Power Slip:** Handled and supported 13,000' of 4" O.D. pipe and 10,000' of 2⅜" O.D. pipe with a total weight of 270,000 lbs. Completely power-operated slip setting and raising.
8. **BJ 13⅜" Casing Spider:** Used to handle casing program including 3,003' of 13⅜" surface casing weighing 120,000 lbs. and 13,486' of 9⅝" casing weighing 530,000 lbs.
9. **BJ 13⅜" Casing Elevator:** side-door, slip grip: Elevator inserts were changed for casing size only (see #8 above) with no visible wear throughout entire program.
10. **BJ Type A Rope Guard,** driller's side: This safety attachment prevented catline fouling.
11. **BJ Catline Grip,** right hand: Held catline secure without damage through entire operation.
12. **BJ PB Wire Line Guide:** Used to absorb whip, lash and traveling waves of drilling line through entire operation.
13. **BJ PB Regular Type Protectors:** Used exclusively and installed one to a stand. Oil base mud with bottom hole temperature of 350°. No slippage or visible deterioration.
14. **BJ Red Top Tong Dies:** Used exclusively.

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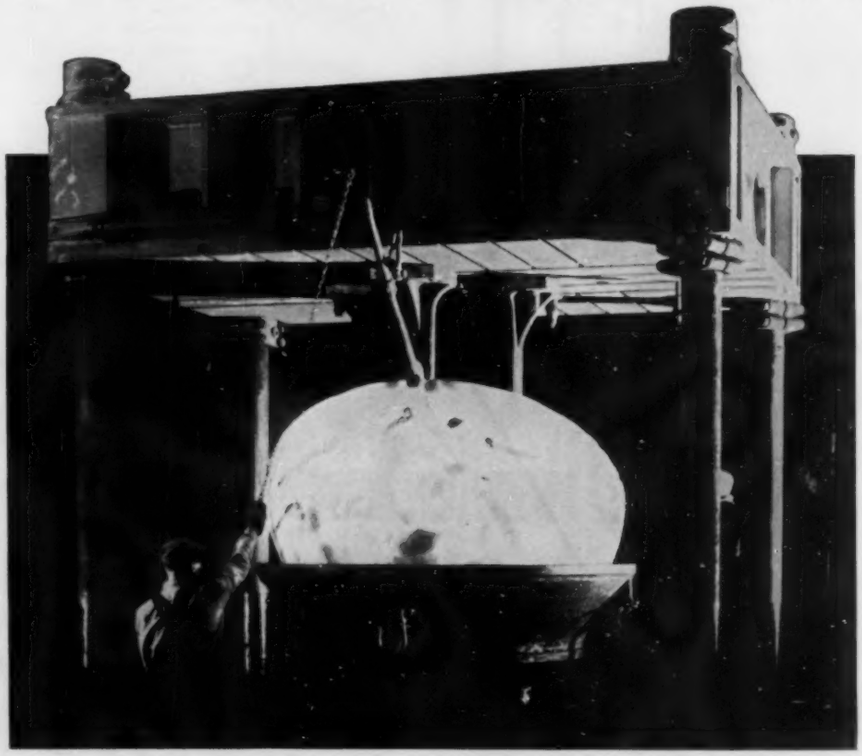
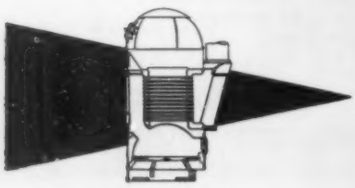


COCHRAN boilers are built from the finest quality Siemens-Martin mild steel plates. The furnace crown, as shown, is pressed from one plate and reaches hemispherical form without weld or seam; this process may require as many as nine heats. By similar hot pressing operations the tube-plates and ogee ring are formed. Whenever a plate is locally heated for shaping, the whole of it is thereafter annealed. Constant observance by skilled craftsmen of best boilermaking practice underlies much of the success of the COCHRAN boiler.



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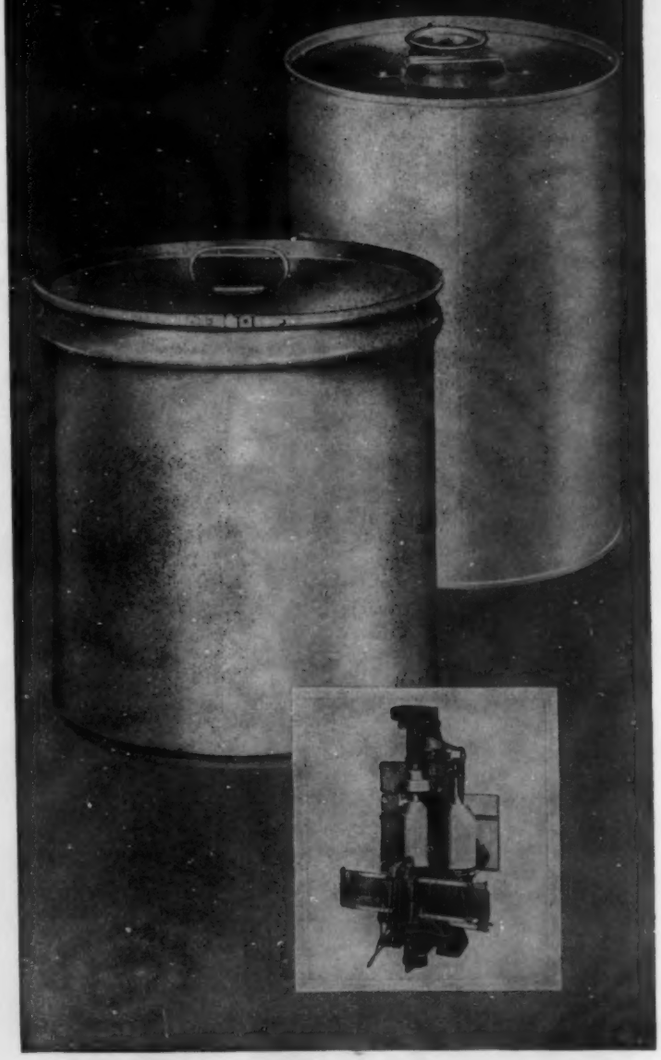

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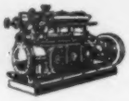

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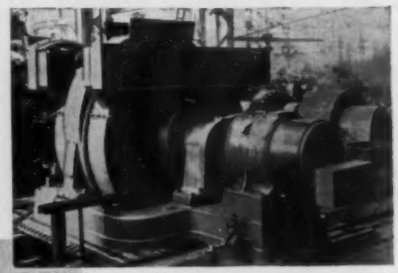
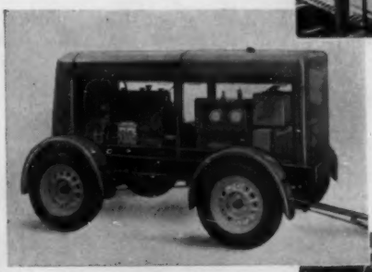
Electric motors breathe too! . . . and these VOKES filters have proved conspicuously successful in preventing the grave damage hitherto sustained during operations in impure air conditions.





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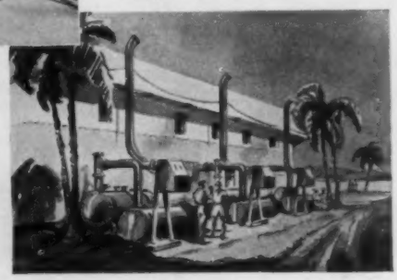

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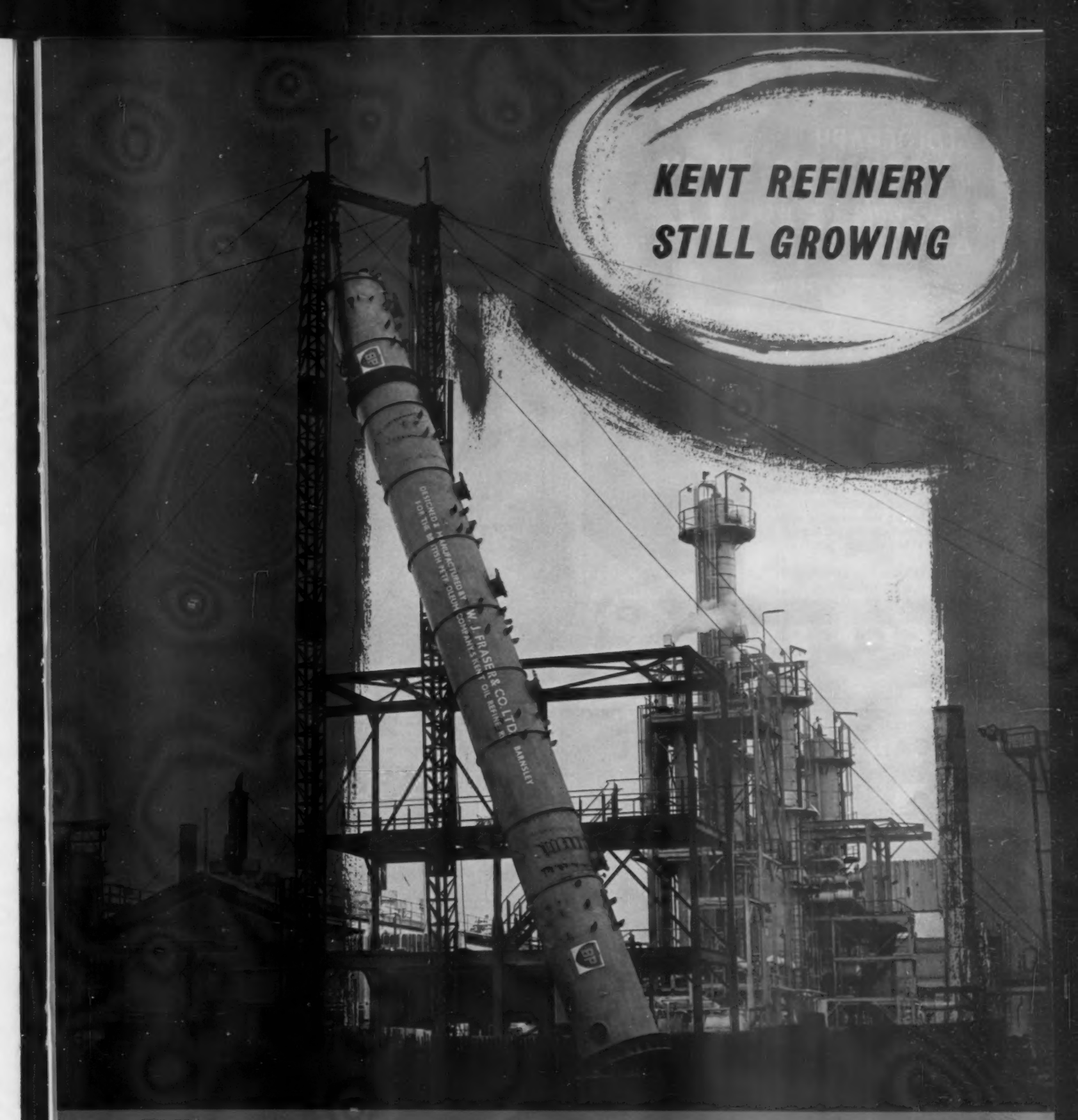

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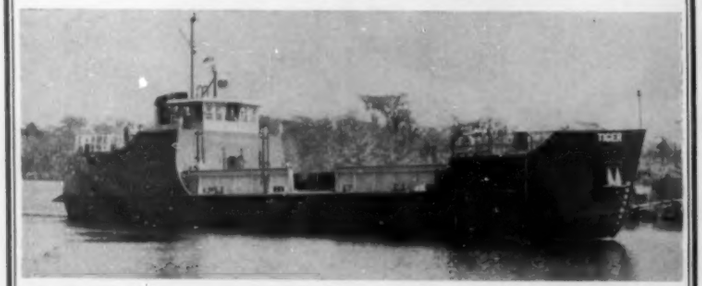

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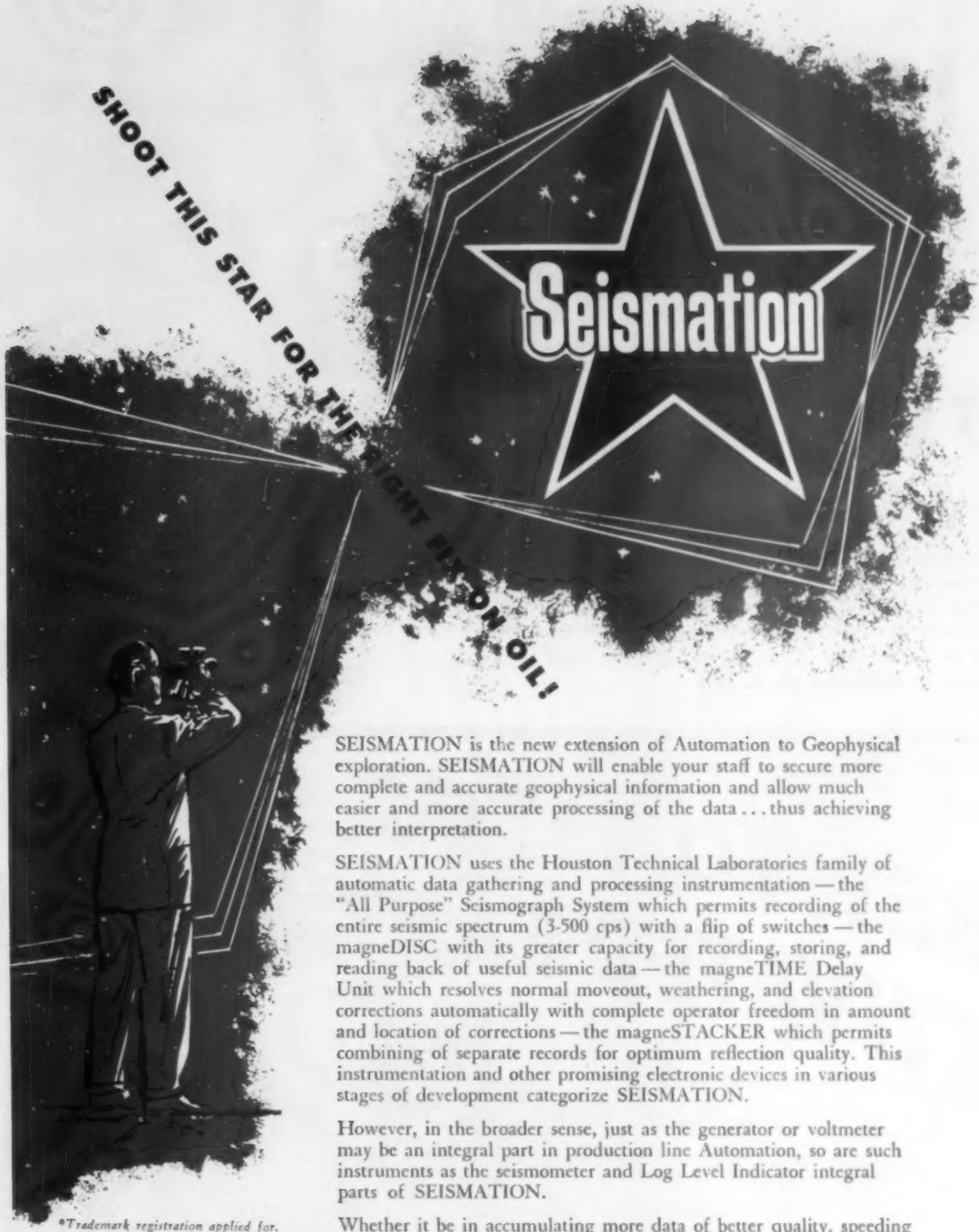

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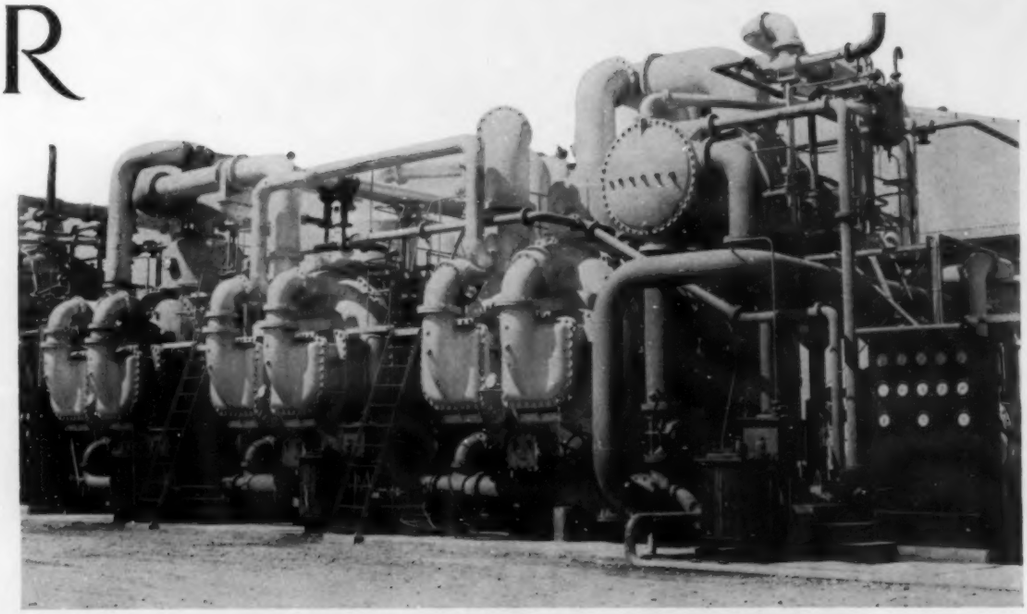

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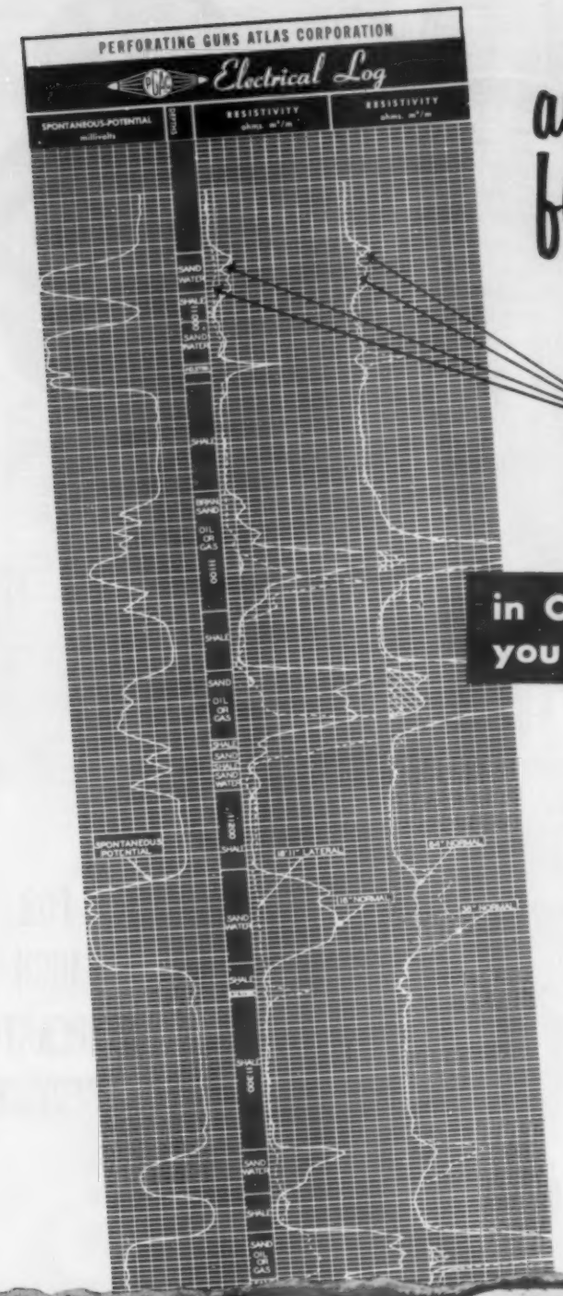

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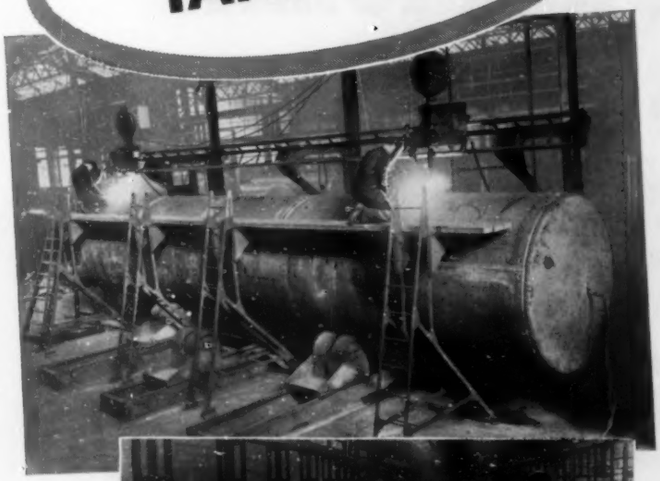

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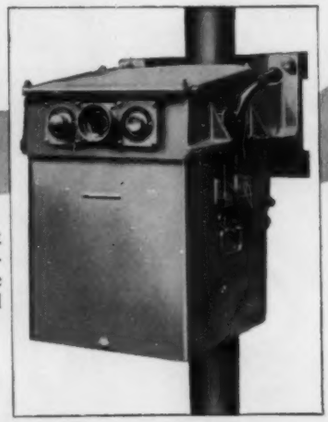
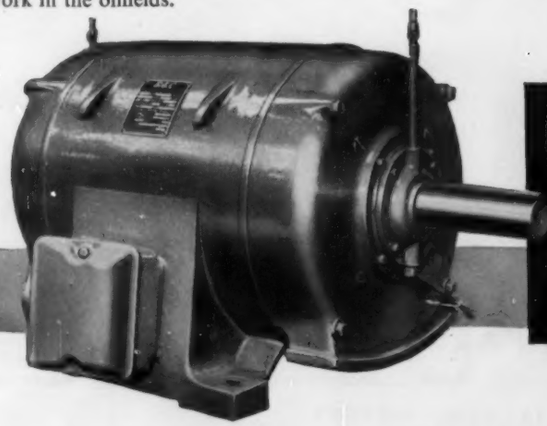
EQUIPMENT FOR THE OIL INDUSTRY

A high torque squirrel cage motor driving a beam type well pump. This installation is on one of the oilfields of Compania Shell de Venezuela.



A combined circuit breaker and contactor starter for the automatic control of oilwell motors.

A G.E.C. weatherproof motor designed and built for arduous work in the oilfields.



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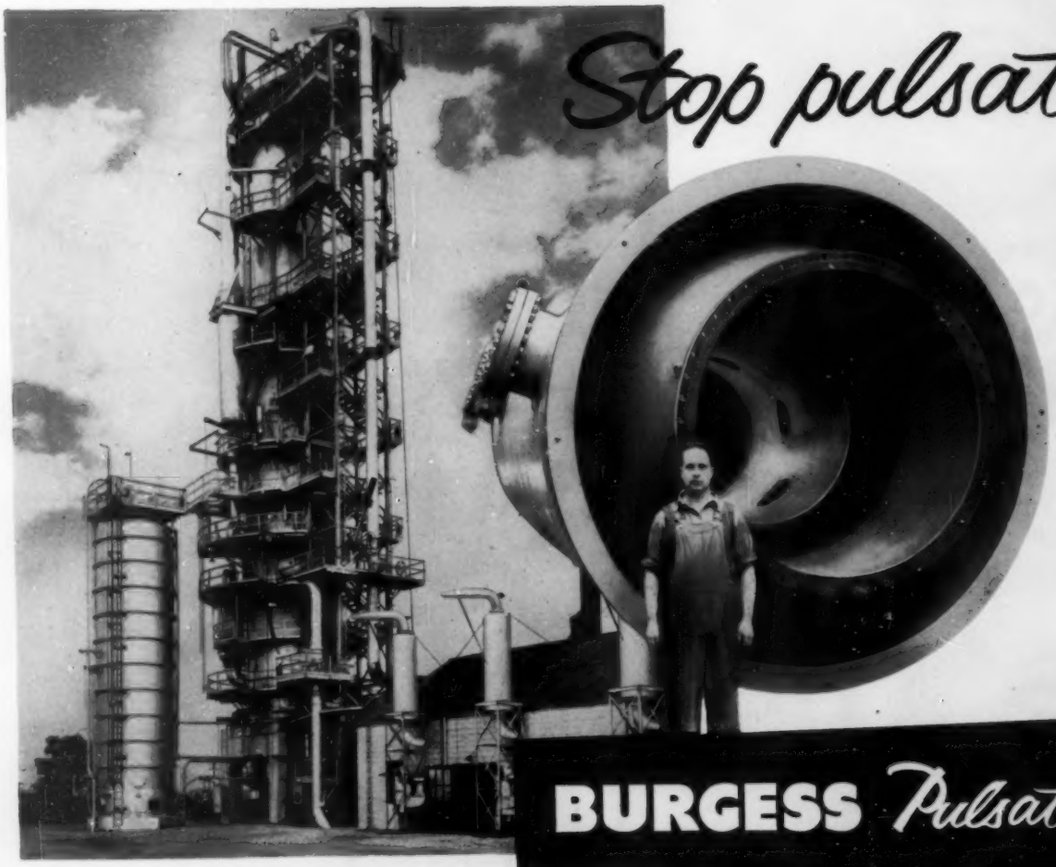
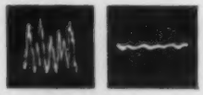


Stop pulsation . . .

Pipes carrying gas and air under pressure from pumps, blowers, or compressors may fail, or require special reinforcement, as a result of surging and the consequent pulsatory vibration. This problem is overcome by fitting BURGESS Snubbers, which convert intermittent flow to smooth flow—and which, by eliminating a cause of line failure, often effect economies by permitting less costly pipes to be used. BURGESS Snubbers are made to the specifications and design of the original American BURGESS-MANNING patents.



Oscilloscope recording shows pulsation (left) and smooth flow attained after fitting BURGESS Snubber (right).

BURGESS *Pulsation Snubbers*

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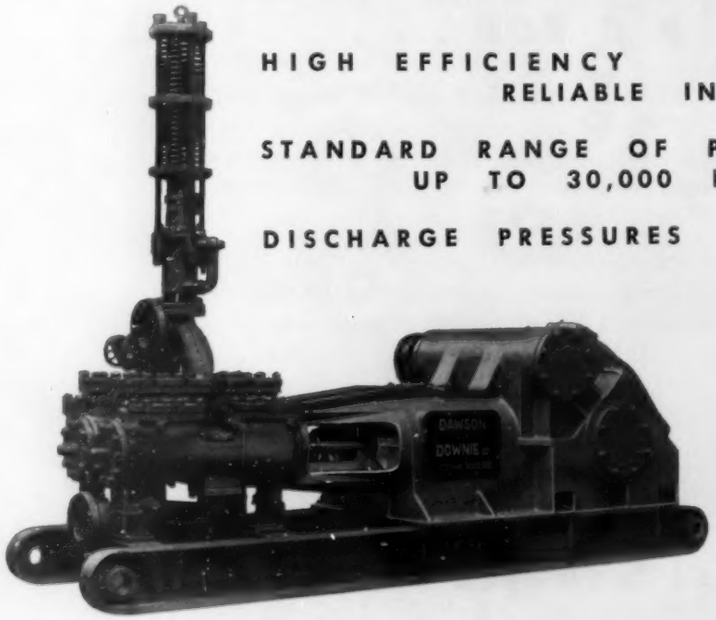

Illustration shows one of a series of pumps supplied to BRITISH PETROLEUM CO. LTD.'S refinery at ADEN, for pumping diesel and fuel oils from the refinery to the B.P. bunkering installation.

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Houdry, Socony Settle Differences

Pending litigation between Houdry Process Corp. and Socony Mobil Oil Co., Inc., involving the Air-lift Thermofor Catalytic Cracking (TCC) process and the Houdriflow Catalytic Cracking process, has been terminated following an agreement made in December and providing for amicable settlement before year's end of all issues existing between them. Under the terms of the agreement, the two companies will exchange full and complete immunities in the field of moving-bed catalytic cracking and the right to receive, use and pass on to licensees technical information and know-how owned or controlled by either company before December 31. They will also grant to each other an irrevocable non-exclusive royalty-free immunity under patent rights for certain inventions in the field of moving-bed catalytic cracking made during a five-year period beginning January 1.

In acquisition of certain patent rights and in settlement of patent claims, Socony Mobil will pay $3,000,000 to Houdry. In addition, with respect to any new TCC licenses granted by Socony during the same five-year period, Socony will pay Houdry $12.50 per barrel of licensed capacity with respect to each paid-up license and .075 cents per barrel out of running royalties received, until such payments amount to $12.50 per daily barrel of capacity.

New Foreign Sales Company Formed By Standard of California

Formation of a new subsidiary, California Crude Sales Co., to market crude oils produced outside of the U. S., has been announced by T. S. Petersen, President of Standard Oil Co. of California. The new company will operate internationally and will centralize activities now carried on by several other subsidiaries. The crude oils will be produced by subsidiary and affiliated companies of California Standard.

President of California Crude Sales is John E. Black of San Francisco, also Manager of California Standard's Foreign Trade Department. P. A. Best of Perth Amboy, N. J., is a vice-president and manager, and A. E. Ojeda, of Rio de Janeiro, Brazil, is also a vice-president.

Two Mergers With Texas Eastern

As of the close of business November 29, 1955, Triangle Pipeline Co., wholly-owned subsidiary, was merged with and into Texas Eastern Production Corp. In turn, as of the close of business November 30, Texas Eastern Production Corp. was merged with and into Texas Eastern Transmission Corp. Under the terms of the merger agreement, Production shares will be converted into shares of Transmission common stock at the rate of 2.6 shares of Production for each share of Transmission common stock. Formal notice is now being sent to the record holders of Production Corp. stock together with a form for their use in the transmittal of shares for exchange.

Glass Cloth Laminate by Kellogg

A new fluorocarbon plastic laminate with high temperature and extreme chemical resistance has been developed by The M. W. Kellogg Co. The new laminate, consisting of a thin—10-12 mil—continuous layer of KEL-F plastic on glass cloth, can be adhesive-bonded to almost any contoured surface. Vessels ranging from rectangular plating tanks to complex reactors involving flanged pipe connections and dished heads, have been lined throughout with the material.

Cities Service Builds Research Center

A new multi-million dollar product research center for Cities Service Co. will be erected by Wigton-Abbott on a 100-acre tract of land in Cranbury, N.J. The structural steel frame building will contain 11 laboratories of various sizes, a lunch room, repair shop with a hydraulic lift, conference room, library, a general office and four executive offices. Plans call for facilities to accommodate 150 scientists and technicians.

Operating engineer injects minute chemical sample into gas-liquid partition chromatography unit newly developed by Gulf Oil laboratories.

New Liquid-Gas Separation Device Developed by Gulf

A basic research advance over present distillation techniques has been developed by Gulf Oil Laboratories. Utilizing a technique developed by English scientists and brought to this country in 1954, Gulf researchers developed a method called gas-liquid partition chromatography which quickly separates gases and liquids whose boiling points are so close that the most elaborate present-day distilling columns either cannot take them apart at all, or require weeks to do so.

New Centrifugal Compressor

A new low flow centrifugal compressor furnishing clean oil-free air for use in instrument air systems and for process air, has been designed by Sawyer Bailey Corp. of Buffalo, N.Y. Flows as low as 350 scfm are delivered at 65 psi abs., requiring 128 H.P. Principal advantage of the centrifugal compressor is its supply of oil-free air to instruments without need of additional equipment.

Big Push Completed by Brown & Root

A 12-mile continuous pipe line "shove" was completed during December in the Louisiana marshes by Brown & Root, Inc. A "shove" is the procedure of joining together lengths of pipe and floating forward the complete string as each joint is added. This push was made through a narrow water-filled canal a total length of 62,105 feet, or almost 12 miles. The total of 9,000 empty 55-gallon oil drums was used to float the 16-inch concrete-coated pipe through the channel. As many as seven drums to the joint of pipe were strapped on with wire in order to float the string. The total weight of the suspended pipe was 12,421,000 pounds.

According to Ed Minor, pipe line manager for Brown & Root, the undertaking was necessary when permission could not be obtained from the land owners to dig a flotation canal in which a lay barge could have been used in the conventional manner. Next step of the operation will be another shove of 44,000 feet of the same type pipe, to be done from a lay barge in a dredged canal.

ElectroData Dedicates New Plant

ElectroData Corp. recently dedicated the first of two new computer plant facilities in Pasadena's scenic Hastings Ranch. The young Pasadena firm was established by Consolidated ElectroDynamics Corp. as an independent affiliate in 1954, to facilitate manufacture and sale of Datratron electronic data processing machines on a full-scale basis.

Socony Plans Major Expansion Program

Socony Mobil Oil Company plans a record $354 million plant and equipment expansion program in the Western Hemisphere during 1956. This compares with $219 million in 1955 and $265 million in 1954. $94 million of the total will go to refinery construction and modernization during 1956, according to B. Brewster Jennings, chairman, and further expenditures are planned during 1957 of $67 million and another $64 million during 1958.

Mr. Jennings gave worldwide production of Socony Mobil during 1955 at 579,000 barrels daily, compared with 536,000 b/d during 1954. Of this production some 318,000 b/d was foreign production during 1955. Company refinery runs averaged 724,000 b/d during 1955, compared with 673,000 b/d during 1954. Foreign refinery runs averaged 183,000 b/d during 1955. The company's production in Venezuela was given at 90,000 b/d, a strong rise over 65,000 b/d in 1954. Socony's share of Middle East production averaged 210,000 b/d during 1955, compared with 182,000 b/d the previous year. Within the U.S. the Williston Basin production was termed "disappointing" by Mr. Jennings.

A.I.Ch.E. Elects 1956 Head

Walter Gordon Whitman, Conference Secretary-General, U.N. International Conference on Peaceful Uses of Atomic Energy, and professor and head of the department of chemical engineering at M.I.T., is the newly elected president of the American Institute of Chemical Engineers for 1956. Since 1951, Prof. Whitman has been chairman, Research and Development Board, Department of Defense, and in addition became a member of the National Advisory Committee for Aeronautics.

Halliburton Appoints Lubbock Manager

Wilfred Tapper, Halliburton Oil Well Cementing Co.'s vice president for electrical well services, has announced the appointment of Leon Daily as manager of electrical well services for the company's Lubbock division, including the Lubbock area of Texas and all of New Mexico. Mr. Daily was formerly EWS district superintendent at Duncan, Okla.

Jones & Laughlin Moves Tulsa/Houston Offices

The Tulsa sales office of the Jones & Laughlin Supply Division has been moved from the Fidelity Union Life Building to larger quarters in the Republic National Bank Building, a newly constructed $25 million, 40-story building located on Pacific at Ervay. Also moved to larger quarters: the central office of the company's Gulf Coast operations in Houston, from the Melrose Building to the Texas National Bank Building at Main and Polk Streets.

Dowell Completes Lab Addition

Dowell Inc. has completed an addition to its chemical research laboratory in Tulsa. The 14,000 square foot addition provides needed space for research in fields of organic, inorganic, physical and analytical chemistry, physics, bacteriology and radio-chemistry. In addition, extensive facilities have been provided for the technical service and field development laboratories. The structure also contains offices, conference rooms, enlarged library, shops, storeroom, snack bar and reception area.

New Type Of Plastic Tank

A new type of plastic tank fitted on to a Leyland Comet "90" chassis has recently been brought into service by Shell in Sweden. The cabin on the chassis is also of plastic manufacture. The plastic material used is a cold-setting polyester resin in combination with glass-fibre cloth and chopped glass straw mat. It is said to be practically as strong as steel, with a specific gravity of 1.7° against 7.7° for steel, enabling —with the same axle load of 6,000 kilos maximum— an extra 10 percent of payload to be carried.

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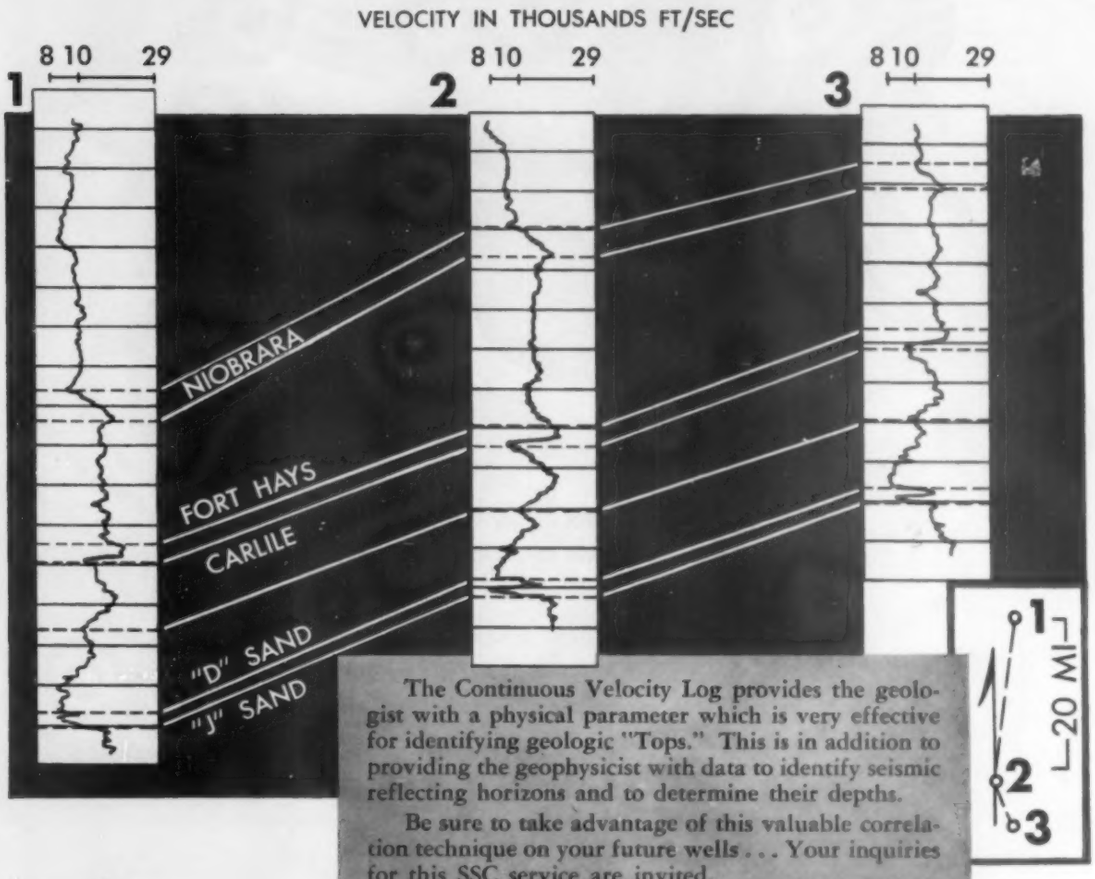

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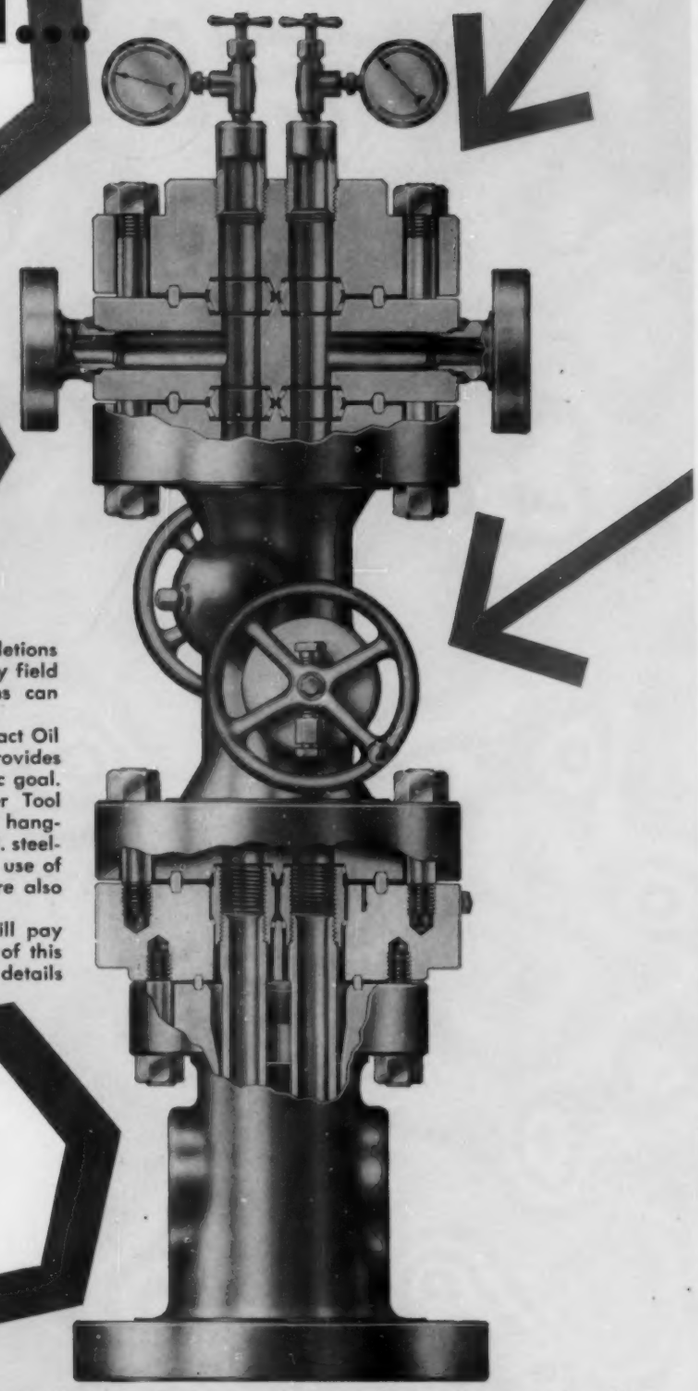

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